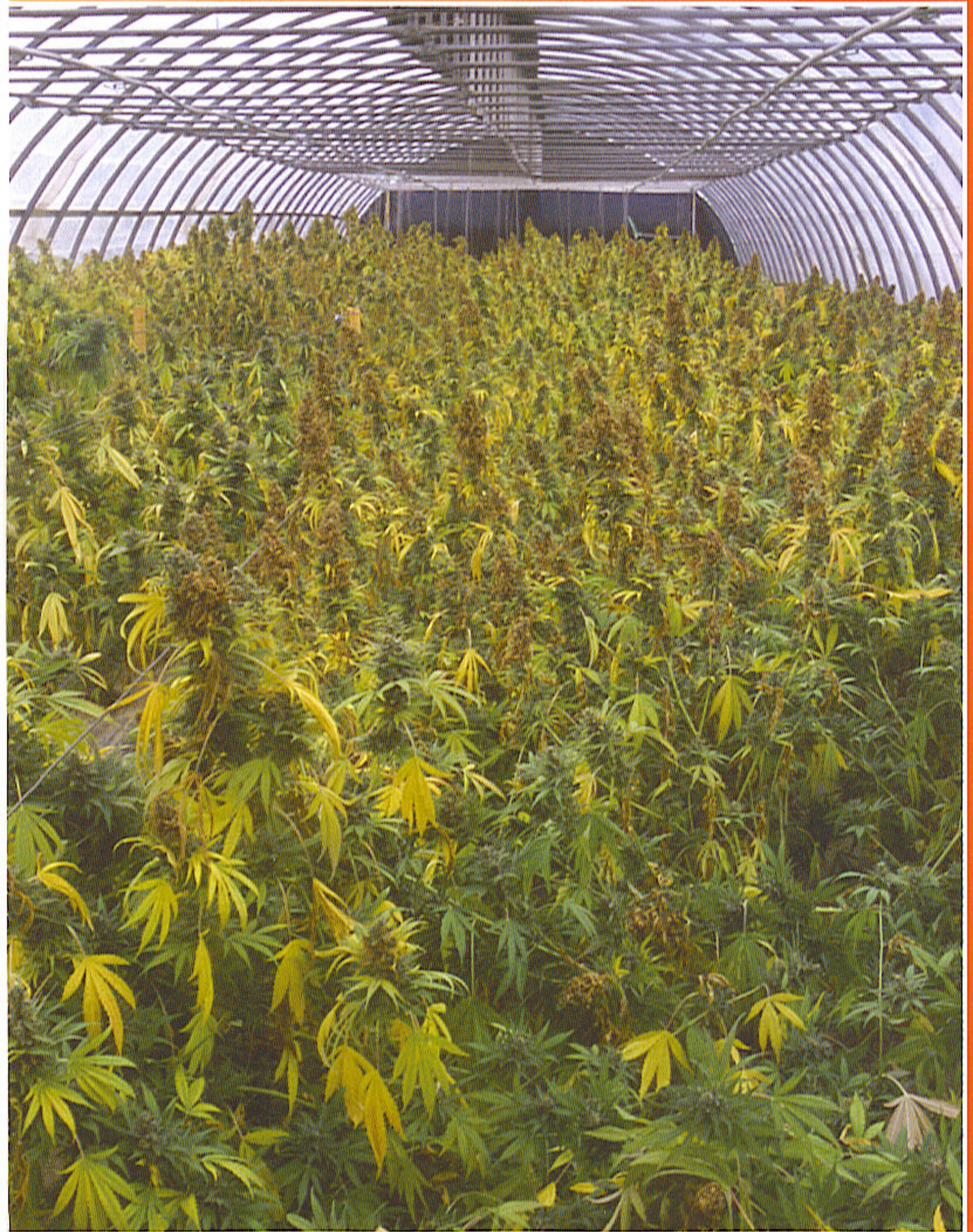


Chapter FOURTEEN

PESTS, FUNGI & DISEASES



This beautiful greenhouse crop was destroyed by botrytis.

VISIT...

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Simple hygiene in the grow room keeps pests and diseases in check.

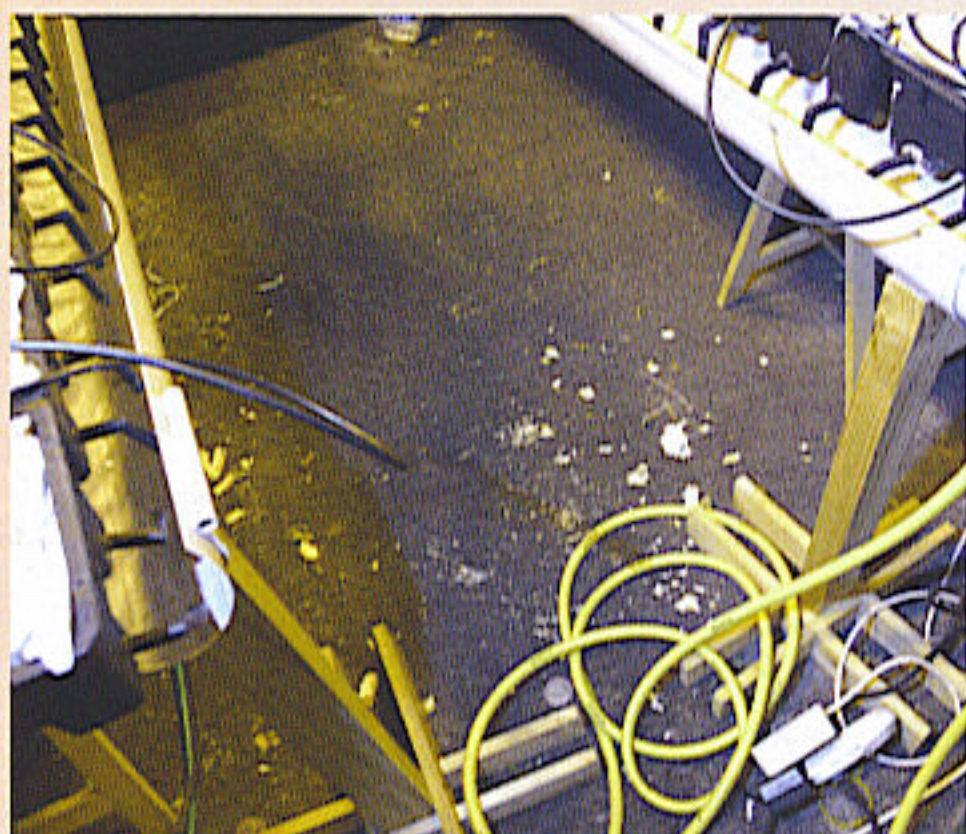
Introduction

Insects, mites, and maggots slither into grow rooms eating, reproducing, and wasting weed. Outdoors, they live everywhere they can. Indoors, they live anywhere you let them. Fungi are present in the air at all times. They may be introduced by an infected plant or from air containing fungus spores. Fungi will settle down and grow if climatic conditions are right. Pests, fungi, and diseases can be prevented, but if allowed to grow unchecked, extreme control measures are often necessary to eradicate them.

Prevention

Cleanliness is the key to insect and fungus prevention. The grow room should be totally enclosed so the environment can be controlled easily. Keep the floor clean. Keep all debris off soil surface. Do not use mulch. Insects and fungi like nice hideaway homes found in dirty, dank corners, and under dead decaying leaves or rotting mulch. Growers and their tools often transport many microscopic pests, diseases, and fungi that could ultimately destroy the garden. This does not mean growers and their tools have to be hospital clean every time they enter a grow room, even though that would be nice. It does mean normal and regular sanitary precautions must be taken. Growers who wear clean clothes and use clean tools reduce problems considerably. A separate set of indoor tools is easy to keep clean. Pests, diseases, and fungi habitually ride from plant to plant on dirty tools. Disinfect tools by dipping in rubbing alcohol or washing with soap and hot water after using them on each diseased plant. Another quick way to sterilize pruners is with a hand-held torch. A quick heating with the torch will sterilize metal tools immediately.

Personal cleanliness is fundamental to preventing pests and diseases. Wash your hands before touching foliage and after handling diseased plants. Smart growers do not walk around the buggy outdoor garden and then visit the indoor garden. They do it vice versa. Think before entering the indoor garden and possibly contaminating it. Did you walk across a lawn covered with rust fungi or pet the dog that just came in from the garden outside? Did you just fondle your spider mite-infested split-leaf philodendron in the living room? Avoid such problems by washing your hands, and changing shirt, pants, and shoes



Dirty grow rooms help cause pest and disease problems.



Sweep the grow room floor every few days to avoid problems with pests and diseases.

before entering an indoor garden.

Once a crop has been grown in potting soil or soilless mix, throw out the grow medium. Some growers brag about using the same old potting soil over and over, unaware that this savings is repaid with a diminished harvest. Used soil may harbor harmful pests and diseases that have developed immunity to sprays. Starting a new crop in new potting soil will cost more up front but will eliminate many potential problems. Used soil makes excellent outdoor garden soil.

Be careful when discarding used soil! Growers in Eugene, Oregon, tossed their outdoor soil out in the backyard for many years. The soil was about 50 percent white perlite and had a distinctive color. This oversight eventually led to the growers' arrest.

Once potting soil is used, it loses much of the fluff in the texture, and compaction becomes a problem. Roots penetrate compacted soil slowly, and there is little room for oxygen, which restricts nutrient uptake. Used potting soil is depleted of nutrients. A plant with a slow start is a perfect target for disease, and worst of all, it will yield less!

Companion planting helps discourage insects outdoors. Pests have nowhere to go indoors, so companion planting is not viable in the grow rooms.

Plant insect- and fungus-resistant strains of marijuana. If buying seeds from one of the many seed companies, always check for disease resistance. In general, *Cannabis indica* is the most resistant to pests, and *sativa* is more resistant to fungal attacks. Choose mother plants that you know are resistant to pests and diseases.

Keep plants healthy and growing fast at all times. Disease attacks sick plants first. Strong plants tend to grow faster than pests and diseases can spread.

Forced air circulation makes life miserable for pests and diseases. Pests hate wind because holding on to plants is difficult, and flight paths are haphazard. Fungal spores have little time to settle in a breeze and grow poorly on wind-dried soil, stems, and leaves.

Ventilation changes the humidity of a room quickly. In fact, a vent fan attached to a humidistat is often the most effective form of humidity control. Mold was a big problem in one of the grow rooms that I visited. The room did not have a vent fan. Upon entering the enclosed room, the



Healthy plants are easy to keep strong and are able to fight off pests and diseases.

humid air was overpowering. It was terrible! The environment was so humid that roots grew from plant stems. The grower installed a vent fan to suck out moist, stale air. The humidity dropped from nearly 100 percent to around 50 percent. The mold problem disappeared, and harvest volume increased.

Indoor horticulturists who practice all the preventative measures have fewer problems with pests and diseases. It is much easier to prevent the start of a disease than it is to wipe out an infestation. If pests and diseases are left unchecked, they can devastate the garden in a few short weeks.

Control

Sometimes, even when all preventative measures are taken, pests and diseases still slink in and set up housekeeping. First, they establish a base on a weak, susceptible plant. Once set up, they launch an all-out assault on the rest of the garden. They move out in all directions from the infested base, taking over more and more space, until they have conquered the entire garden. An infestation can happen in a matter of days. Most insects lay thousands of eggs in short periods of time. These eggs hatch and grow into mature adults within a few weeks. For example, if 100 microscopic munchers each laid 1000 eggs during their two weeks of life and these eggs grew into adults, two weeks later 100,000 young adults would lay 100 eggs each. By the end of the month, there would be 100,000,000 pests attack-

Logical Progression of Insect Control

- | | |
|-----------------------------|----------------------|
| 1. Prevention | 2. Manual Removal |
| a. Cleanliness | a. fingers |
| b. Use new soil | b. sponge |
| c. One indoor set of tools | |
| d. Disease-resistant plants | 3. Organic Sprays |
| e. Healthy plants | |
| f. Climate control | 4. Natural Predators |
| g. No animals | |
| h. Companion planting | 5. Chemicals |



Manually remove small populations of pests by smashing pests and eggs between your fingers. Make sure to wash your hands afterward.



A 30X battery-powered magnifying scope makes insects and diseases easier to identify.

ing the infested garden. Imagine how many there would be in another two weeks!

Sprays often kill adults only. In general, sprays should be applied soon after eggs hatch so young adults are caught in their weakest stage of life. Very lightweight (low viscosity) horticultural oil spray works well alone or as an additive to help kill larvae and eggs.

The availability of some sprays can be seasonal, especially in more rural areas. Garden sections of stores are changed for the winter, but extra stock is sometimes kept in a storage room. Look for bargains on sprays at season-end sales. Today, there are many indoor grow stores that carry pest and disease controls all year round.

Insect Control

Indoor gardeners have many options to control insects and fungi. Prevention and cleanliness are at the top of the control list. A logical progression to pest and disease control is outlined in the chart on this page. (Note that it begins with cleanliness!)

Manual removal is just what the name implies—smashing all pests and their eggs in sight between the thumb and forefinger or between two sponges.

I like natural-organic sprays such as pyrethrum and neem and use harsh chemicals only as a last resort. Any spray, no matter how benign, always seems to slow plant growth a little. Stomata become clogged when foliage is sprayed and covered with a filmy residue. Stomata stay



Yellow sticky traps are used to monitor pest populations as well as to control small flying insects.

Common chemicals with their trade names and the insects they control:

Note: Do not apply these substances to edible plants

Generic Name	Purpose	Enter System
Griseofulvin	fungicide	systemic
Streptomycin	bactericide	systemic
Carbaryl	fungicide	systemic
Tetracycline	bactericide	semi synthetic (Terramycin®)
Nitrates	foliar fertilizers	systemic
Avid	insecticide	not truly systemic, actually translaminar
Pentac	miticide	systemic
Temik	insecticide	systemic
Neem	insecticide	systemic
Funginex	fungicide	systemic
Vitavax	fungicide	systemic
Orthene	insecticide	systemic

NOTE: This list is not all-inclusive. The basic rule is to not use systemic products.

plugged up until the spray wears off or is washed off. Stronger sprays are often more phytotoxic, burning foliage. Spray plants as little as possible and avoid spraying for two weeks before harvest. Read all labels thoroughly before use.

Use only contact sprays that are approved for edible plants. Avoid spraying seedlings and tender unrooted cuttings. Wait until cuttings are rooted and seedlings are at least a month old before spraying.

Sprays and Traps

Chemical fungicides, insecticides, and miticides

I do not recommend using chemical fungicides, fungistats, insecticides, or miticides on plants that are destined for human consumption. Most contact sprays that do not enter the plant system are approved for edible fruits and vegetables. However, there are numerous ways to control fungi, diseases, and pests without resorting to

EPA pesticide acute toxicity classification:

Class	LD50 to kill Rat Oral (mg kg-1)	LD50 to kill Rat Dermal (mg kg-1)	LD50 to kill Rat Inhaled (mg kg-1)	Eye Effects	Skin Effects
I	50 or less	200 or less	0.2 or less	corrosive opacity not reversible	corrosive
II	50-500	200-2000	0.2-2.0	corneal opacity reversible within 7 days, irritation persists for 7 days	severe irritation at 72 hours
III	500-5000	2000-20,000	2.0-20	no corneal opacity, irritation reversible within 7 days	moderate irritation at 72 hours
IV	> 5000	> 20, 000	> 20	no irritation	mild irritation

Natural Remedy Chart

Generic name	Form	Trade name	Toxicity Precautions
Active ingredient			EPA Class
Bacillus species	G, D, WP	Bt, DiPel, M-Trak, Match, Javelin, etc.	IV
Copper sulfate	D, WP	Brsicop	III
Copper sulfate/lime	D, WP	Bordeaux mixture	III
Diatomaceous earth	D	Celite	IV
Neem	O, EL	Neem, Bioneem	IV
Nicotine sulfate	L, D	Black Leaf 40	II
Oil, dormant horticultural	O	Sunspray	IV
Pyrethrins	A, L, WP	Many trade names	III, IV
Quassia	WP	Bitterwood	IV
Rotenone	D, WP, EC	Derris, Cubé	II, III
Ryania	D, WP	Dyan 50	IV
Sabadilla	D	Red Devil	IV
Soap, insecticidal	L	M-Pede, Safer's	IV
Sodium bicarbonate	P	Baking soda	IV
Sodium hypochlorite	L	Bleach	II, III
Sulfur	D, WP	Cosan	V
Legend A - Aerosol D - Dust EL - Emulsifiable Liquid L - Liquid WP - Wettable Powder O - Oil G - Glandular			

chemicals. On the previous page is a chart of common chemicals with their trade names and the insects they control.

Spreader-Sticker for Pesticides

Spreader-stickers improve and promote wetting and increase sticking and absorption through foliage. Spreader-sticker products increase effectiveness of fertilizers, fungicides, insecticides, etc. They are especially important to use when plants develop a waxy coating of resin. Spreader-stickers also impair insects' respiration mechanisms and function as pesticides. One of my favorite spreader-stickers is Coco-Wet from Spray-N-Grow.

Abamectin

Ingredients: Abamectin derivatives include emamectin and milbemectin. Does not bioaccumulate. Used extensively on hops; abamectin is not truly systemic. It is absorbed from the exterior of foliage to other leaf parts, especially young leaves, in the process of translaminar activity.

Controls: Russet and spider mites, fire ants,

leafminers, and nematodes.

Mixing: Dilute in water. Mix 0.25 teaspoon (0.125 cl) per gallon (3.8 L). Use a wetting agent.

Application: Spray. Works best when temperature is above 70°F (21°C). Repeat applications every seven to ten days.

Persistence: One day.

Forms: Liquid.

Toxicity: Toxic to mammals, fish, and honeybees in high concentrations. Sucking insects are subject to control while beneficials are not hurt.

Safety: Wear gloves, mask, and safety glasses.

Bacillus thuringiensis (Bt) and other *Bacillus* species

Ingredients: *Bacillus thuringiensis* (Bt) is the best known of several bacteria that are fatal to caterpillars, larvae, and maggots.

Caterpillars, larvae, and maggots all eat Bt bacteria, which can be applied as a spray, dust, or granules. Inject liquid Bt into stalks to kill borers. Shortly after they ingest it, their appetite is ruined, and they stop eating. Within a few days they shrivel up and die; cabbage loopers, cabbage-

worms, corn earworms, cutworms, gypsy moth larvae, and hornworms are controlled. Commercial *Bt* products do not reproduce within insect bodies, so several applications may be necessary to control an infestation. Microbial *Bt* bacteria are nontoxic to animals (humans), beneficial insects, and plants; however, some people do develop an allergic reaction. Commercial *Bt* products do not contain living *Bt* bacteria, but the *Bt* toxin is extremely perishable. Keep within prescribed temperature range, and apply according to the directions. Most effective on young caterpillars, larvae, and maggots, so apply as soon as they are spotted.

Get the most out of *Bt* applications by adding a UV inhibitor, spreader-sticker, and a feeding stimulant such as Entice®, Konsume® or Pheast®. *Bt* is completely broken down by UV light in one to three days.

B. thuringiensis var. *kurstaki* (*Btk*)—introduced on the market in the early 1960s—is the most popular *Bt*. Toxic to many moth and caterpillar larvae including most of the species that feed on flowers and vegetables. Sold under many trade names *DiPel*®, *BioBit*®, *Javelin*®, etc., *Btk* is also available in a microencapsulated form, *M-Trak*®, *Matth*®, etc. The encapsulation extends the effective life on foliage to more than a week.

B. thuringiensis var. *aizawai* (*Bta*) is effective against hard-to-kill budworms, borers, armyworms and pests that have built up a resistance to *Btk*.

B. thuringiensis var. *israelensis* (*Bt-i*) is effective against the larvae of mosquitoes, black flies, and fungus gnats. Look for *Gnatrol*®, *Vectobac*®, and *Bacrimos*®. All are lethal to larvae. Adults do not feed on plants and are not affected. Fungus gnats can cause root problems including rot. Use *Bti* to get rid of them as soon as they are identified.

B. thuringiensis var. *morrisoni* is a new strain of *Bt* under development for insect larvae with a high pH in their guts.

B. thuringiensis var. *san diego* (*Btsd*) targets the larvae of Colorado potato beetles and elm beetle adults and other leaf beetles.

B. thuringiensis var. *tenebrionis* (*Btt*) is lethal to Colorado potato beetle larvae.

B. cereus helps control damping-off and root-knot fungus. It flourishes in water-saturated mediums and promotes beneficial fungus that attacks the diseases.

B. subtilis is a soil-dwelling bacterium that curbs

Fusarium, *Pythium*, and *Rhizoctonia* that cause damping-off. It is commercially available under the brand names *Epic*®, *Kodiac*®, *Rhizo-Plus*®, *Serenade*®, etc. Soak seeds and apply as a soil-drench.

B. popilliae colonize larvae and grub bodies that consume it, causing them to turn milky-white before dying. It is often called *milky spore disease*. It is most effective against Japanese beetle grubs.

Baking soda

Ingredients: Sodium bicarbonate.

Controls: Powdery mildew.

Caution: Baking soda kills fungus by changing the pH of foliage surface. It functions as a fungistat, not as a fungicide, that eradicates the organisms.

Mixing: Saturate in water.

Application: Spray or dust foliage.

Persistence: One to three days.

Forms: Powder.

Toxicity: None to mammals, fish, beneficials.

Safety: Wear a mask to avoid inhaling dust.



Bleach, laundry

Ingredients: Sodium hypochlorite.

Controls: Numerous bacteria and fungi.

Caution: Avoid skin contact and inhalation. Concentrate burns skin and stains clothes.

Mixing: Dilute 5 or 10 percent solution with water.

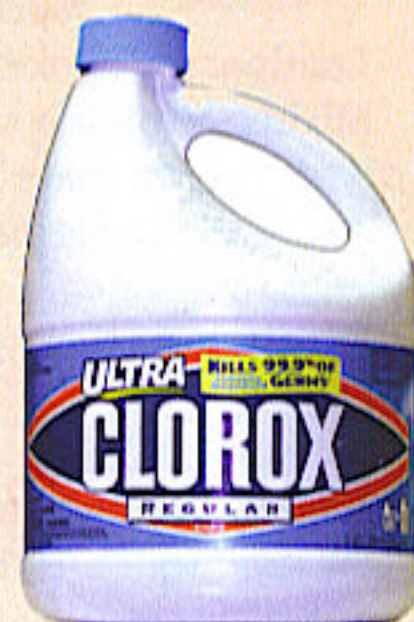
Application: Use as a disinfectant on containers, walls, tools, etc.

Persistence: Evaporates with little residual in a couple of days.

Forms: Liquid.

Toxicity: Toxic to fish, beneficials, and humans if swallowed or gets in eyes.

Safety: Wear a mask and gloves when handling concentrate. Avoid skin contact and respiration.



Bordeaux mixture

Ingredients: Water, sulfur, copper (copper sul-

fate) and lime (calcium hydroxide).

Controls: Most often used as a foliar fungicide. Also, controls bacteria and fends off other insects.

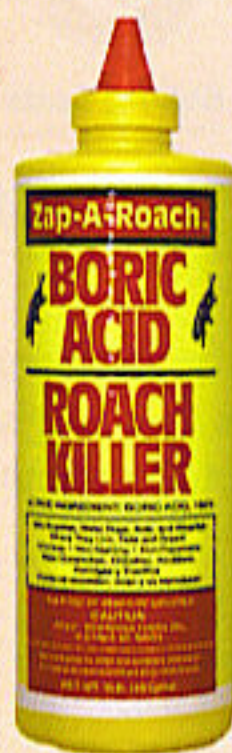
Caution: Phytotoxic when applied to tender seedlings or foliage in cool and humid conditions.

Mixing: Apply immediately after preparing.

Application: Agitate the mixture often while spraying so ingredients do not settle out.

Persistence: Until it is washed from foliage.

Forms: Powder and liquid.



Toxicity: Not toxic to humans and animals, but somewhat toxic to honeybees and very toxic to fish.

Safety: Wear a mask, gloves, and long sleeves.

Boric acid

Ingredients: Available in the form of borax hand soap and dust.

Controls: Lethal as a contact or stomach poison. Kills earwigs, roaches, crickets, and ants.

Caution: Phytotoxic when applied to foliage.

Mixing: Mix borax soap in equal parts with powdered sugar to make toxic bait.

Application: Set bait out on soil near base of plants.

Persistence: Avoid getting bait wet as it disperses rapidly.

Forms: Powder.

Toxicity: Not toxic to honeybees and birds.

Safety: Avoid breathing dust.

Bug Bombs

Ingredients: Often bug bombs are packed with very strong insecticides and miticides, including synthetic pyrethrins that exterminate every pest in the room. They were developed to kill fleas, roaches, and their eggs that hide in furniture and in carpets.

Controls: According to most bug bomb labels, they kill everything in the room!

Caution: Use only as a last resort and follow the label's instructions to the letter.

Mixing: None.

Application: Place the bug bomb in the empty room. Turn it on and then leave the room.

Persistence: Low residual. Persistence is limited to a day or two.

Forms: Aerosol.

Toxicity: Read label for details.

Safety: Wear a mask, gloves, and cover exposed skin and hair.

Copper

Ingredients: The compounds—copper sulfate, copper oxychloride, cupric hydroxide and cuprous oxide—are common forms of fixed copper used as a fungicide and are less phytotoxic than unfixed (pure) copper.

Controls: Gray mold, foliar fungus, anthracnose, blights, mildews, and a number of bacterial diseases.

Caution: Easy to overapply and burn foliage or create a copper excess in plant.

Mixing: Apply immediately after preparing.

Application: Agitate the mixture often while spraying, so ingredients do not settle out. Preferred temperature range for application is 65-85°F (18-29°C).

Persistence: Lasts two weeks or longer indoors, if not washed off.

Forms: Powder and liquid.

Toxicity: Toxic to fish. Not toxic to birds, bees, mammals.

Safety: Wear a mask and gloves, cover exposed skin and hair.



Diatomaceous Earth (DE)

Ingredients: Naturally occurring DE includes fossilized-silica-shell, remains of the tiny one-celled or colonial creatures called diatoms. It also contains 14 trace minerals in a chelated (available) form.

Controls: Although not registered as a pesticide or fungicide, DE abrades the waxy coating on pest shells and skin, including aphids and slugs, causing body fluids to leak out. Once ingested, the razor-sharp particles in DE rip tiny holes in the pest's guts, causing death.

Caution: Do not use swimming pool diatomaceous earth.



Chemically treated and heated, it contains crystalline silica that is very hazardous if inhaled. The body is unable to dissolve the crystalline form of silica that causes chronic irritation.

Mixing: No mixing required when used as a dust. Mixing required when used as spray. Apply as a powder or encircle slug-damaged plants and use as a barrier.

Application: Apply this spray to infestations caused by pest insects.

Persistence: Stays on foliage for a few days or until washed off.

Forms: Powder.

Toxicity: Earthworms, animals, humans, and birds can digest diatomaceous earth with no ill-effects. Avoid contact with skin and eyes.

Safety: Wear a protective mask and goggles when handling this fine powder to guard against respiratory and eye irritations.

Homemade Pest and Disease Sprays

Ingredients: A strong, hot taste, smelly odor, and a desiccating powder or liquid are the main ingredients in home-brewed pesticide and fungicide potions. See below.

Controls: Homemade sprays discourage and control pests including aphids, thrips, spider mites, scale, and many others.

Caution: Be careful when testing a new spray. Apply it to a single plant and wait for a few days to learn the outcome before applying to all plants.

Mixing: Make spray concentrates by mixing repellent substances with a little water in a blender. Strain the resulting slurry concentrate through a nylon stocking or fine cheesecloth before being diluted with water for application.

Application: Spray foliage until it drips from both sides of leaves.

Persistence: A few days.

Forms: Liquid.

Toxicity: Usually not toxic to humans in dosages lethal to pests.

Safety: Wear a mask and gloves, and cover skin and hair. Avoid contact with eyes, nose, lips, and ears.

Neem

Ingredients: Relatively new in the USA, neem has been used for medicine and pest control for more than four centuries in India and Southeast Asia. Extracted from the Indian neem tree, *Azadirachta indica*, or the chinaberry tree, *Melia azedarach*, neem is an antifeedant and disrupts



Homemade sprays can be made by blending water, lemon, vegetable oil, and garlic.

insect life cycles. The trees are known as the village pharmacy because they supply cures for humans and animals as well as safely control countless pests and fungi. Neem powder is made from leaves. The active ingredient, azadirachtin, confuses growth hormones and pests never mature into adults to produce more young. It is most effective against young insects and is available in various concentrations. It also contains N-P-K and trace elements.

Controls: Most effective against caterpillars and other immature insects including larvae of whiteflies, fungus gnats, mealybugs, and leafminers.

Caution: Neem is not as effective against spider mites as neem oil.

Mixing: Often mixed with vegetable (canola) oil. Mix just before using in water with a pH below 7 and use a spreader-sticker. Agitate constantly while using to keep emulsified, throw out excess.

Application: Use as a soil-drench or add to the nutrient solution. This allows neem to enter into the plant's tissue and become systemic. Used as

Recipes and Controls Chart

Ingredients:

Alcohol: Use isopropyl (rubbing). Add to sprays to dry out pests.

Bleach: Use a 5 percent solution as a general disinfectant.

Cinnamon: Dilute cinnamon oil with water. Use just a few drops per pint as pesticide.

Citrus: Citrus oils make great ingredients that kill insects dead.

Garlic: Use a garlic press to squeeze garlic juice into mix. Use liberal amounts.

Horseradish: Stinky stuff! Add as you would garlic. Best to use fresh root.

Hot pepper: Dilute Tabasco® or any store-bought concentrate in water.

Hydrated lime: Saturate in water to form a fungicide.

Mint: Mint oil drives insects away. Dilute in water, measure several drops per pint.

Oil, vegetable is comprised mainly of fatty acids and glycerides. Mix with rubbing alcohol to emulsify in water. Great stuff!

Oregano: Grind up fresh herb and use as a repellent. Mix with water.

Soap: I like Ivory® or Castille® soap. Use as an insecticide and wetting agent. Mix with water.

Tobacco: Mix tobacco with hot water to extract the poisonous alkaloid. Do not boil. Dilute concentrate with water.

Recipe 1. Mix three tablespoons (4.5 cl) each of isopropyl alcohol, lemon juice, garlic juice, horseradish juice, Ivory liquid, and a few drops of Tabasco®, mint, and cinnamon oil. Mix all of the ingredients in a small bowl into a slurry. Dilute the slurry at the rate of one teaspoon (0.5 cl per 47 cl) per pint of water and mix in a blender. Potent mix!

Recipe 2. Place one teaspoon (0.5 cl) of hot pepper or Tabasco® sauce and four cloves of garlic in a blender with a pint of water and liquefy, then strain through a nylon stocking or cheesecloth before using in the sprayer.

Recipe 3. A mix of one-eighth to one-quarter cup (3-6 cl) of hydrated lime combined with a quart (0.9 L) of water makes an effective insect

Precautions:

Cooking or heating preparations can destroy active ingredients. To draw out (extract) ingredients, mince plant and soak in mineral oil for a couple of days. Add this oil to the water including a little detergent or soap to emulsify the oil droplets in water. Biodegradable detergents and soaps are good wetting-sticking agents for these preparations. Soap dissolves best if a teaspoon (0.75 cl) of alcohol is also added to each quart (0.9 L) of mix.

Chrysanthemum, marigold, and nasturtium blossoms; pennyroyal; garlic; chive; onion; hot pepper; insect juice (target insects mixed in a blender); horseradish; mint; oregano; tomato; and tobacco residues all will repel many insects including aphids, caterpillars, mites, and whiteflies.

Spray made from pests ground up in a blender and emulsified in water will reputedly repel related pests. Best used on large pests! The insecticidal qualities in the dead bug parts will degrade quickly if combined with other things; do not include insects mixed in a blender with other ingredients besides water. Mixes that include tobacco may kill these pests if it is strong enough. These mixes can vary in proportions, but always filter the blended slurry before mixing with water for the final spray. Straining avoids clogging spray nozzles and plumbing.

and mite spray. Mix a non-detergent soap with lime. The soap acts as both a sticking agent and insecticide. Lime can be phytotoxic to plants in large doses. Always try the spray on a test plant and wait a few days to check for adverse effects to the plant before applying to similar plants.

Recipe 4. Liquid laundry bleach—sodium hypochlorite—is a good fungicide for non-plant surfaces. Mix as a five or ten percent solution. It is an eye and skin irritant, so wear gloves and goggles when using it. Mix 1 part bleach to 9 parts water for a 5 percent solution. Mix one part to four parts water for a 10 percent solution. Use this solution as a general disinfectant for grow room equipment, tools, and plant wounds. The bleach solution breaks down rapidly and has little, if any, residual effect.

a spray, neem becomes a contact spray and an antifeedant when eaten by pests. Performs best in rooms with 60 percent plus humidity.

Persistence: Contact neem stays on foliage for up to a month or until it is washed off. Stays in plant system up to a month when absorbed via roots.

Forms: Emulsifiable concentrate.

Toxicity: Not toxic to honeybees, fish, and earthworms. Not toxic to beneficial insects in normal concentrations that kill target insects.

Safety: Irritates eyes; wear a mask and gloves.

Neem Oil

Ingredients: Purified extract from neem seeds. Buy only cold-pressed oil that is stronger and contains all the natural ingredients. Do not use heat-processed neem oil. Cold-pressed oil also contains azadirachtin, the active ingredient in neem. Brand names include Neemguard®, Triact®, and Einstein Oil®. NOTE: Einstein Oil works the best of all brands tested.

Controls: Effective against spider mites, fungus gnats, and aphids. It is also a fungistat against powdery mildew and rust.

Caution: Neem oil is very effective against spider mites.

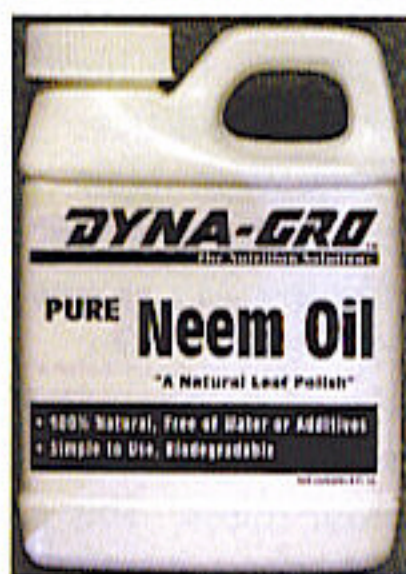
Mixing: Mix just before using in water with a pH below 7 and use a spreader-sticker. Agitate constantly while using to keep emulsified. Throw out excess.

Application: Spray on foliage, especially under leaves, where mites live. Apply every few days so hatching larvae will eat it immediately. Spray heavily so mites have little choice but to eat it. Avoid spraying the last few days before harvest. Some growers report a foul taste when applied just before harvest.

Persistence: Contact neem stays on foliage for up to a month or until it is washed off. Stays in



Einstein Oil



Neem Oil

plant system up to a month when absorbed via roots.

Forms: Emulsifiable concentrate.

Toxicity: Toxicity to beneficial insects has been reported. Not toxic to humans.

Safety: Irritates eyes, wear a mask and gloves.

Neem products have numerous other applications. For more information check out the Neem Foundation, <http://www.neemfoundation.org>, and the Neem Association, hometown.aol.com/neemassoc, and www.einsteinoil.com, or the book, *Neem: India's Miraculous Healing Plant*, by Ellen Norten, ISBN: 0-89281-837-9.

Nicotine and Tobacco Sprays

Ingredients: Nicotine is a non-persistent pesticide derived from tobacco, *Nicotiana tabacum*. It is a stomach poison, contact poison, and respiratory poison. This very poisonous compound affects the neuromuscular system, causing pests to go into convulsions and die. Nicotine sulfate is the most common form.

Caution: Do not swallow any of this vile poison, and avoid skin contact. Do not use around nightshade family—eggplants, tomatoes, peppers and potatoes—because they may contract Tobacco Mosaic Virus (TMV) from exposure to tobacco-based substances.

Controls: Sucking and chewing insects.

Mixing: Use a spreader-sticker.

Application: Seldom phytotoxic when used as directed. Combine with insecticidal soap to increase killing ability.

Persistence: One week to ten days.

Forms: Liquid.

Toxicity: Although naturally derived, nicotine is very toxic to most insects (including beneficials), honeybees, fish, and humans. If concentrate is ingested or built up over years, humans may develop lung cancer and other cancers.

Safety: Wear a mask and gloves; avoid skin and eye contact.

Oil, horticultural

Ingredients: Often underrated and overlooked as an insecticide and miticide, horticultural oil is very popular in greenhouses and is regaining popularity among indoor growers. Similar to medicinal mineral oil, horticultural oils are made

from animal (fish) oils, plant seed oils, and petroleum oils refined by removing most of the portion that is toxic to plants. Lighter weight oil (viscosity 60-70) is less phytotoxic. Vegetable oil is also horticultural oil.

Controls: Virtually invisible, horticultural oil kills slow moving and immobile sucking insects, spider mites and their eggs by smothering, as well as generally impairing their life cycle.

Caution: Do not use lubricating oils such as 3-in-1 or motor oil!

Mixing: Mix $\frac{3}{4}$ teaspoon (0.75 cl) of oil spray—no more than a one percent solution—per quart (0.9 L) of water. More than a few drops could burn tender, growing shoots.

Application: Spray foliage entirely, including under the surface of the leaves. Apply oil sprays up until two weeks before harvest. Repeat applications as needed. Usually three applications, one every five to ten days, will put insects and mites in check. Lightweight-oil residue evaporates into the air in a short time.

Persistence: Disappears in one to three days, under normal growing conditions.

Forms: Liquid

Toxicity: Safe, non-poisonous, and non-polluting insecticide. Can become phytotoxic if too heavy (viscosity), if applied too heavily, or when temperatures are below 70°F (21°C), or very humid; this slows evaporation, increasing phytotoxicity.

Safety: Wear a mask and gloves.

Oil, vegetable

Ingredients: Fatty acids and glycerides.

Controls: Lightweight vegetable oil kills slow-moving and immobile sucking insects, spider mites, and their eggs by smothering as well as generally interrupting their life cycles.

Caution: Vegetable oil does not kill as well as horticultural oil.

Mixing: Mix two drops of oil spray—no more than a one percent solution—per quart of water.

Application: Spray foliage entirely, including under surface of leaves. Stop spraying two weeks before harvest.

Persistence: Several days.

Forms: Liquid.

Toxicity: Not toxic to mammals or fish.

Safety: Wear a mask and gloves.

Pyrethrum

Ingredients: Pyrethrum, the best-known botanical pesticide, is extracted from the flowers of the pyrethrum chrysanthemum, *Chrysanthemum coccineum* and *C. cinerariifolium*. Pyrethrins—pyrethrins, cinerins, and jasmolins—are the active ingredients in natural pyrethrum and kills insects on contact. Pyrethrum is often combined with rotenone or ryania to ensure effectiveness. Aerosol forms contain synergists. (See "Application" below.)

Controls: A broad-spectrum contact pesticide, pyrethrum kills aphids, whiteflies, spider mites, and insects including beneficials. It is very effective to control flying insects, but they must receive a killing knockdown dose, or they may revive and buzz off.

Caution: Do not mix with sulfur, lime, copper, or soaps. The high pH of these substances render it ineffective. Wash these substances off foliage with plain water (pH below 7) before applying pyrethrum.

Mixing: Mix in water with a pH below 7 and use a spreader-sticker.

Application: Spot spray infested plants. Aerosol sprays are most effective especially on spider mites. This can burn foliage—spray is ice-cold when it exits the nozzle—if applied closer than one foot. Aerosol sprays contains a synergist, piperonyl butoxide (PBO) or MGK 264. Both are toxic to people. Pyrethrum dissipates within a few hours in the presence of air, HID light, and sunlight. Overcome this limitation by applying just before turning off the lights, the circulation, and vent fans for the night. One manufacturer, Whidmere®, offers encapsulated pyrethrum in aerosol form called Exclude®. As the spray fogs out of the nozzle, a bubble forms around each droplet of pyrethrum mist. The outside coating keeps the pyrethrum intact and extends its life for several days. When a pest prances by touching the bubble, it bursts, releasing the pyrethrum. Liquid and wettable pyrethrum applied with a pump-type sprayer is difficult to apply under leaves where spider mites live.

Persistence: Effective several hours after application when the lights are on, longer when applied after lights-out and the fan is turned off.



Pyrethrum

Forms: Wettable powder, dust, liquid, granular bait, and aerosol.

Toxicity: Not toxic to animals and humans when eaten, but becomes toxic to people when inhaled. It is toxic to fish and beneficials.

Safety: Wear a mask and protective clothing when applying sprays or breathing in any form of pyrethrum, especially aerosols. Aerosols contain toxic PBO and MGK 464—possible carcinogens—which are easily inhaled.

Synthetic Pyrethroids

Ingredients: Synthetic pyrethroids such as permethrin and cypermethrin act as broad-spectrum, non-selective contact insecticides and miticides. There are more than 30 synthetic pyrethroids available in different formulations. Deltamethrin is available as a sticky paint that is used as a trap when applied to stems and colored objects. Other pyrethroids include Allethrin, cyflutrin, fenpropathin, phenothrin, sumithrin, resmethrin, and tefluthrin.

Controls: Aphids, whiteflies, thrips, beetles, cockroaches, caterpillars, and spider mites. NOTE: Many insects and mites are resistant to pyrethroids.

Caution: Non-selective pyrethroids kill all insects and mites including beneficials and bees.

Mixing: Follow directions on container.

Application: Follow directions on container. (See "Application" under "Pyrethrum" above.)

Persistence: Breaks down in one to three days. Newer pyrethroids, such as Permethrin, stay active the longest.

Forms: Powder, liquid, aerosol.

Toxicity: Toxic to all insects. It is somewhat toxic to mammals.

Safety: Wear a mask and protective clothing when applying sprays or breathing in any form of pyrethrum, especially aerosols. Aerosols contain toxic PBO and MGK 464—possible carcinogens—which are easily inhaled.

Quassia

Ingredients: Quassia is made from a subtropical South American tree, *Quassia amara*, and the tree-of-heaven, *Ailanthus altissima*.

Controls: Soft-bodied insects including aphids, leafminers, and some caterpillars.

Mixing: Available in the form of bark, wood chips, and shavings. Soak 6 ounces (18 cl) of chips per gallon (0.9 L) of water for 24 hours.

Afterward, boil for two hours. Add a potassium-based soap to increase effectiveness. Strain and cool before spraying.

Application: Spray on foliage until saturated.

Persistence: Two to five days on the surface of plants.

Forms: Bark, wood chips, and shavings.

Toxicity: Safe for mammals and (possibly) beneficials.

Safety: Wear a mask and gloves.

Rotenone

Ingredients: Rotenone is an extract of roots of several plants including *Derris* species, *Lonchocarpus* species, and *Tephrosia* species. This poison is a non-selective contact insecticide, stomach poison, and slow-acting nerve poison.

Controls: Non-selective control of beetles, caterpillars, flies, mosquitos, thrips, weevils, and beneficial insects, but death is slow. According to *Hemp Diseases and Pests*, target insects can consume up to 30 times their lethal dose before dying!

Caution: Kills beneficials. New evidence indicates rotenone may be toxic to people and may cause Parkinson's disease. Use only as a last resort!

Mixing: Follow directions on the package.

Application: Follow directions on the package.

Persistence: Breaks down in three to ten days.

Forms: Powder, wettable powder, liquid.

Toxicity: The effect on mammals is undetermined. Chronic exposure may cause Parkinson's. It is toxic to birds, fish, and beneficials.

Safety: Wear a mask and gloves; cover exposed skin and hair. Avoid skin contact.

Ryania

Ingredients: This contact-alkaloid stomach poison is made from stems and roots of the tropical shrub, *Ryania speciosa*.

Controls: Toxic to aphids, thrips, European corn borers, hemp borers, flea beetles, leaf rollers, and many caterpillars. Once pests consume ryania, they stop feeding immediately and die within 24 hours.

Caution: Somewhat toxic to beneficials and mammals!

Mixing: Follow directions on package.

Application: Follow directions on package. Apply as dust.

Persistence: Two weeks or longer.

Forms: Powder, wettable powder.

Toxicity: Toxic to mammals, birds, fish, and beneficials.

Safety: Wear a mask, gloves, and safety glasses, and cover exposed skin and hair. Avoid skin contact.

Sabadilla

Ingredients: This alkaloid pesticide is made from the seeds of a tropical lily, *Schoenocaulon officinale*, native to Central and South America, and a European hellebore, *Veratrum album*.

Controls: A contact and stomach poison, this centuries-old poison controls aphids, beetles, cabbage loopers, chinch bugs, grasshoppers, and squash bugs.

Caution: Very toxic to honeybees and moderately toxic to mammals!

Mixing: Follow directions on package.

Application: Most potent when applied at 75-80°F. Follow directions on package.

Persistence: Two or three days.

Forms: Powder, liquid.

Toxicity: Somewhat toxic to mammals, toxic to honeybees.

Safety: Wear a mask, gloves, and safety glasses, and cover exposed skin and hair. Avoid skin, eye, ear, and nose contact. Irritates eyes and nose.

Seaweed

Ingredients: Numerous elements including nutrients, bacteria, and hormones.

Controls: Suspended particles in seaweed impair, and even kill, insects and spider mites by causing lesions. The particles cut and penetrate the soft-bodied pest insects and mites causing their body fluids to leak out.

Mixing: Dilute as per instructions for soil application.

Application: Spray on foliage, especially under leaves where mites live.

Persistence: Up to two weeks when spreader-sticker is used.

Forms: Powder and liquid.

Toxicity: Not toxic to mammals, birds, and fish. Non-selective, kills beneficials.

Safety: Wear a mask and gloves.

Soap, insecticidal

Ingredients: Mild contact insecticides made

from fatty acids of animals and plants. A variety of soaps are available in potassium-salt based liquid concentrates. Soft soaps such as Ivory liquid dish soap, Castille soap, and Murphy's Oil soap are biodegradable and kill insects in a similar manner to commercial insecticidal soaps, but they are not as potent or effective.

Controls: Controls soft-bodied insects such as aphids and mealy bugs, spider mites, thrips, and whiteflies by penetrating and clogging body membranes.

Caution: Do not use detergent soaps because they may be caustic.

Mixing: Add a few capfuls of soap to a quart of water to make a spray. Ivory or Castille soap can also be used as a spreader-sticker to mix with other sprays. The soaps help the spray stick to the foliage better.

Application: Spray at the first appearance of insect pests. Follow directions on commercial preparations. Spray homemade mixes every four to five days.

Persistence: Soft soaps will last only for about a day before dissipating.

Forms: Liquid.

Toxicity: These soaps are safe for bees, animals, and humans.

Safety: Wear a mask and gloves.

Sulfur

Ingredients: Sulfur. Mixed with lime, sulfur is more toxic to insects but more phytotoxic to plants.

Controls: Centuries-old fungicide is effective against rusts and powdery mildew.

Caution: Do not apply in temperatures above 90°F (32°C) and less than 50 percent humidity. It will burn foliage.

Mixing: Follow directions on package.

Application: Apply in light concentration. It is phytotoxic during hot, 90°F, arid weather.

Persistence: It stays on foliage until washed off.

Forms: Powder.

Toxicity: Not toxic to honeybees, birds, and fish.



Safer
Insecticidal
Soap



Sulfur
Fungicide



Tanglefoot

Safety: Wear a mask, gloves, and safety goggles; cover exposed skin and hair. Avoid skin, eye, ear, and nose contact. Irritates eyes, lungs, and skin.

Traps

Ingredients: Sticky traps, such as Tanglefoot™ resins, can be smeared on attractive yellow or red cards to simulate ripe fruit. When the pests land on the fruit, they are stuck forever!

Controls: Helps contain spider mites and non-flying insects within the bounds of the barriers. Monitors fungus gnat populations and helps control thrips. Other insects get stuck haphazardly to the sticky stuff.

Black-light traps catch egg-laying moths and other flying insects most of which are not plant pests. Light and fan traps attract many insects including beneficials, and their use may do more harm than good.

Sex-lure traps exude specific insect pheromones, sexual scents, of females that are ready to mate. These traps are most effective to monitor insect populations for large farms.

Caution: Do not touch sticky substance. It is difficult to remove!

Mixing: Follow directions on container. Smear on desired objects.

Application: Smear Tanglefoot™ around the edges of pots, base of stems, and at the end of drying lines to form an impenetrable barrier-trap against mites and insects. This simple precaution helps keep mites isolated. However, resourceful spider mites can spin a web above the barrier. The marauding mites also ride the air currents created by fans from plant to plant!

Persistence: It is persistent until it is wiped off or completely fouled with insect bodies.

Forms: Sticky, thick paint.

Toxicity: Not toxic to mammals or insects. Trapped insects and mites starve to death.

Safety: Wear gloves.

Water

Ingredients: A cold jet of water—preferably with a pH between 6 and 7—blasts insects, spider mites, and their eggs off leaves and often kills

them. Hot water vapor and steam also work as a sterilant.

Controls: A cold jet of water is an excellent first wave of attack against spider mites, aphids, and other sucking insects. Steam controls spider mites, insects, and diseases on pots, growing medium, and other grow-room surfaces.

Caution: Avoid spraying fully formed buds with water. Standing water in or on buds promotes gray mold. Do not apply hot steam to foliage.

Mixing: None.

Application: Spray leaf undersides with a jet of cold water to knock off sucking spider mites and aphids. Apply water as a mist or spray when predatory mites are present. The extra humid conditions impair the pest mite lifecycles and promote predatory mite health. Rent a wallpaper steamer. Get it cooking, and direct a jet of steam at all grow-room cracks and surfaces.

Persistence: None.

Forms: Liquid, steam vapor.

Toxicity: Not toxic to mammals, fish, and beneficials.

Safety: Do not spray strong jet of water in eyes, up nose, or into other body orifices.

Biological Controls

Predators and Parasites

Predator and parasite availability and supply have changed substantially over the last 10 years. Today, many more predators and parasites are available to home growers than ever before. Shipping, care, cost, and application of each predator or parasite is very specific and should be provided in detail by the supplier. Make sure the supplier answers the following questions:

- 1) Latin name of the predator so there is no confusion as to identity.
- 2) Specific pests attacked.
- 3) Life cycle.
- 4) Preferred climate including temperature and humidity range.
- 5) Application rate and mode of application.

For more information about predators check out the following web pages:

www.naturescontrol.com

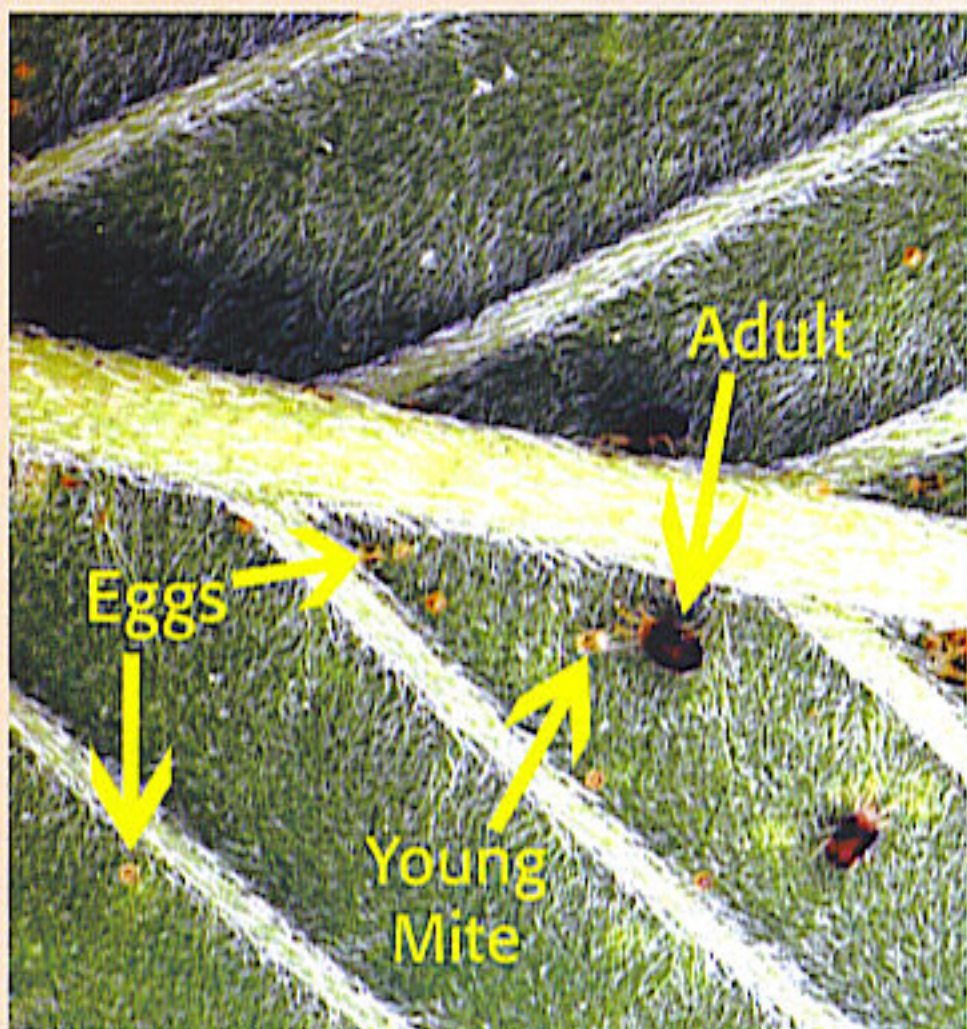
www.koppert.nl/english

www.entomology.wisc.edu/mbcn/mbcn.html

By definition, a predator must eat more than one victim before adulthood. Predators, such as ladybugs (ladybird beetles) and praying mantises, have chewing mouthparts. Other predators, such as lacewing larvae, have piercing-sucking mouth-



Spiders are predatory and eat other insects. If you see a spider in the garden, let it help you!



Young spider mites, adults, and eggs are visible in this photo.

parts. Chewing predators eat their prey whole. The piercing, sucking-type, suck the fluids from their prey's body.

Parasites consume a single individual host before adulthood. Adult parasitoids typically place a single egg into many hosts. The egg hatches into larvae that eat the host insect from the inside out. They save the vital organs for dessert! Most often, the larvae pupate inside the host's body and emerge as adults.

Parasites, unlike predators, hunt until the prey is almost eliminated. Predators choose to be surrounded by prey. When prey population starts to diminish a little, predators move on to find a nice, fat infestation. They never truly eradicate the pests. This is why predators work best for preventative control, but are slow to stop an infestation.

The rate at which the predators and parasites keep the infestation in check is directly proportionate to the amount of predators. The more predators and parasites, the sooner they will get infestations into check. Predators and parasites outbreed their victims, reproducing faster than pests are able to keep up with.

One of the best places in the country to buy predatory and parasitoid insects is from Nature's Control, Medford, Oregon. Check out their very informative web site at www.naturescontrol.com. This supplier gives advice and supplies specific care and release instructions. Nature's Control has a good predator and parasite supply and can ship year round. Predators and parasites are shipped special delivery and may arrive after the daily-mail delivery. Make sure to pick them up as soon as they arrive. Do not let predators sit inside a mailbox in the hot sun. It could easily reach 120°F (49°C) or more!

When predators and parasites are introduced into a garden, special precautions must be taken to ensure their well-being. Stop spraying all-toxic chemicals at least two weeks before introducing the predators. Pyrethrum and insecticidal soaps can be applied up to a few days before, providing any residue is washed off with fresh water. Do not spray after releasing predators and parasites.

Predators and parasites survive best in gardens that are not sterilized between crops. Gardens with perpetual harvests are ideal for predators.

Most of the predators and parasites that do well in an indoor HID garden cannot fly. Insects that can fly often head straight for the lamp. Ladybugs are the best example. If 500 ladybugs are released on Monday, by Friday, only a few die-

hards will be left. The rest will have popped off the lamp. If using flying predators or parasitoids, release when it is dark. They will live longer.

Predators are most often very small and must be introduced to each plant separately. Introducing predators to a garden and plants takes a little time and patience. Predators also have very specific climatic requirements. Pay attention to the predators' needs and maintain them for best results.

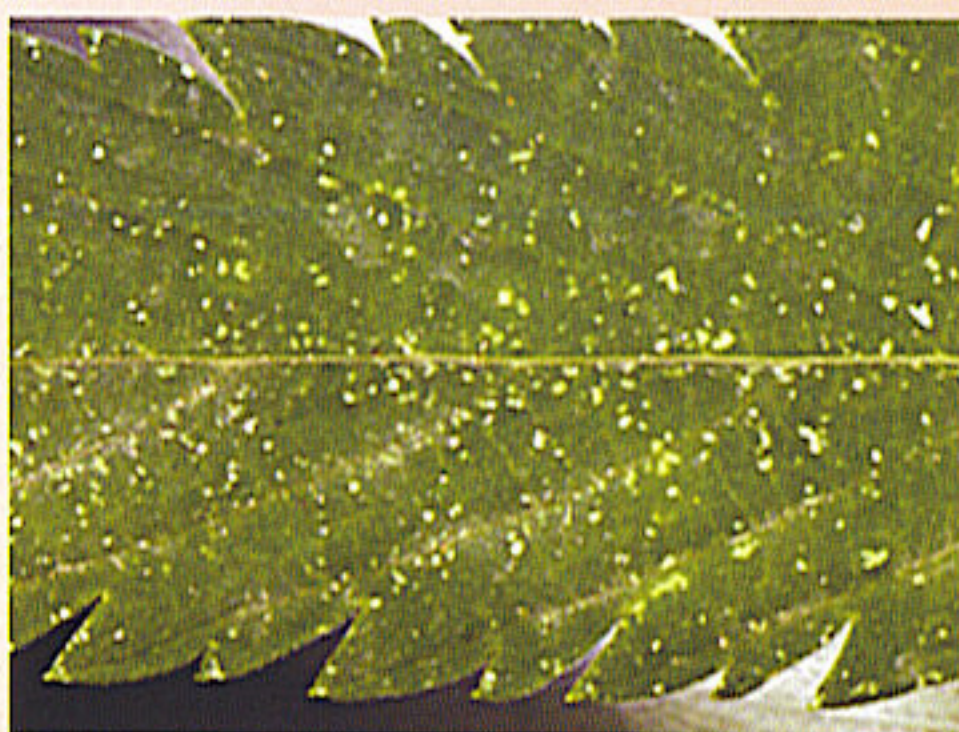
Spider Mites and Insects

Here is one of the best web sites I have found that describes insects. They have excellent photos of all pests and predators that attack marijuana:

<http://vegipm.tamu.edu/imageindex.html>

Spider Mites

Identify: The spider mite is the most common pest found on indoor plants and causes the most problems. Spider mites have eight legs and are classified as spiders rather than insects, which have six legs. Find microscopic spider mites on leaf undersides sucking away life-giving fluids. To an untrained naked eye, they are hard to spot. Spider mites appear as tiny specks on leaf undersides; however, their telltale signs of feeding—yellowish-white spots, stippling—on the tops of leaves are easy to see. Careful inspection reveals tiny spider webs—easily seen when misted with water—on stems and under leaves as infestations progress. A magnifying glass or low-power microscope (10-30X) helps to identify the yellow-white, two-spotted brown or red mites and their translucent eggs. Indoors, the most common is the two-spotted spider mite. After a single mat-



Spider mites cause stippling, small spots, on the top of leaves.



This is the worst spider mite infestation I have seen!



Remove leaves with 50 percent or more damage.

ing, females are fertilized for life and reproduce about 75 percent female and 25 percent male eggs. Females lay about 100 eggs.

Damage: Mites suck life-giving sap from plants, causing overall vigor loss and stunting. Leaves are pocked with suck-hole marks and yellow from failure to produce chlorophyll. They lose partial to full function, and leaves turn yellow and drop. Once a plant is overrun with spider mites, the infestation progresses rapidly. Severe cases cause plant death.

Controls: Cleanliness! This is the most important first step to spider mite control. Keep the grow room and tools spotless and disinfected. Mother plants often have spider mites. Spray mothers regularly with miticides, including once three days before taking cuttings. Once mite infestations get out of control and miticides work poorly, the entire grow room will have to be cleaned out and disinfected with a pesticide and 5 percent bleach solution. Steam disinfection is also possible but too difficult in most situations.

Cultural and physical control: Spider mites thrive in a dry, 70-80°F (21-27° C) climate, and reproduce every five days in temperatures above 80°F (27° C). Create a hostile environment by lowering the temperature to 60°F (16°C) and spray foliage, especially under leaves, with a jet of cold water. Spraying literally blasts them off the leaves as well as increases humidity. Their reproductive cycle will be slowed, and you will have a chance to kill them before they do much damage. Manual removal works for small populations. Smash all mites in sight between the thumb and index finger, or wash leaves individu-

ally in between two sponges. Avoid infecting other plants with contaminated hands or sponges.

Remove leaves with more than 50 percent damage and throw away, making sure insects and eggs do not reenter the garden. If mites have attacked only one or two plants, isolate the infected plants and treat them separately. Take care when removing foliage not to spread mites to other plants. Severely damaged plants should be carefully removed from the garden and destroyed.

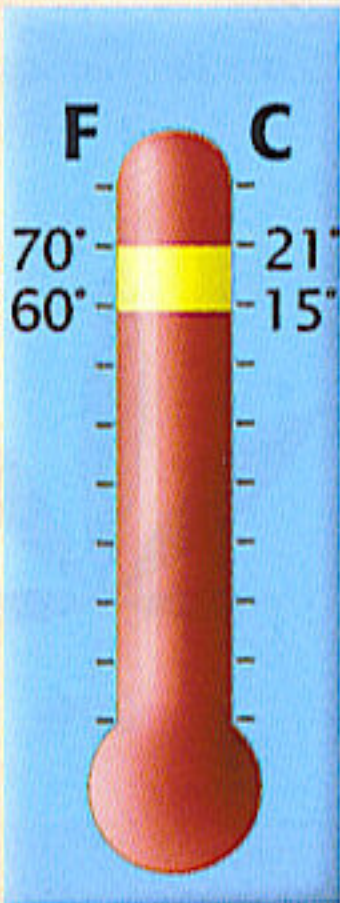
Smear a layer of Tanglefoot™ around the lips of containers and at the base of stems to create barriers spider mites cannot cross. This will help isolate them to specific plants. Note: smear a layer of Tanglefoot™ at each end of drying lines when hanging buds to contain spider mites. Once foliage is dead, mites try to migrate down drying lines to find live foliage with fresh, flowing sap.

Biological: *Neoseiulus (Amblyseius) californicus* and *Mesoseiulus (phytoseiulus) longipes*, are the two most common and effective predators. *Phytoseiulus persimilis*, *Neoseiulus (Amblyseius)*



Keep relative humidity below 50 percent to discourage spider mites.

If plants are infested with spider mites, lower the temperature to 60-70°F (10-21°C). This temperature range will slow their reproduction.



Progressive Control Measures for Spider Mites

Cleanliness - Clean room daily, disinfect tools, do not introduce new pests into the garden on clothes, no animal visits, etc.

Create hostile environment - Humidity, temperature, water spray.

Create barriers - Smear Tanglefoot™ around pot lips, stems, drying lines.

Dip cuttings and vegetative plants - Dip small plants in pyrethrum, horticultural oil, neem oil.

Remove damaged foliage - Remove foliage more than 50 percent damaged.

Introduce predatory mites - Release predators before infestations grow out of hand.

Spray - Apply pyrethrum or neem oil; use strong miticides only if necessary. Rotate sprays so mites do not develop immunity.

fallacius, *Galendromus* (*Metaseiulus*) *occidentalis*, and *Galendromus* (*Typhlodromus*) *pyri* predators are also available commercially.

When properly applied and reared, predatory spider mites work very well. There are many things to consider when using the predators. First, predators can eat only a limited number of mites a day; the average predator can eat 20 eggs or 5 adults daily. As soon as the predators' source of food is gone, some mites die of starvation while others survive on other insects or pollen. Check with suppliers for release instructions of specific species. A general dosage of 20 predators per plant is a good place to start. Predatory mites have a difficult time traveling from plant to plant, so setting them out on each plant is necessary. Temperature and humidity levels must be at the proper levels to give the predators the best possible chance to thrive. When spider mites have infested a garden, the predatory mites cannot eat them fast enough to solve the problem. Predatory mites work best when there are only a few spider mites. Introduce predators as soon as spider mites are seen on vegetative growth, and release them every month thereafter. This gives predators a chance to keep up with mites. Before releasing predators, rinse all plants thoroughly to ensure all toxic-spray residues from insecticides and fungicides are gone.

The fungus, *Hirsutella thompsonii*, trade name Mycar®, kills spider mites.

Sprays: Homemade sprays often lack the strength to kill infestations but work as a deterrent by repelling mites. Popular homemade sprays include Dr. Bonner's Soap, garlic, hot pepper, citrus oil, and liquid seaweed combinations. If these sprays do not deter spider mites after four to five applications, switch to a stronger spray: neem oil, pyrethrum, horticultural oil, or nicotine sulfate, cinnamaldehyde.

Insecticidal soap does a fair job of controlling mites. Usually two or three applications at five to ten day intervals will do the trick.

Horticultural oil smothers eggs and can be mixed with pyrethrum and homemade sprays to improve extermination.

Pyrethrum (aerosol) is the best natural miticide! Apply two to three applications at five to ten day intervals. Pyrethrum is the best control for spider mites. Spider mites should be gone after two or three applications at five to ten day intervals, providing sanitary preventative conditions are maintained. Eggs hatch in five to ten days. The second spraying will kill the newly hatched eggs and the

remaining adults. The third and subsequent applications will kill any new spider mites, but mites soon develop a resistance to synthetic pyrethrum.

Neem oil works great!

Heavy-duty chemical miticides are available but are not recommended on plants that will be consumed by humans. If using any chemical miticide, be sure it is a contact poison and not systemic. Use StirrupM®, described below, to improve the spider mite kill rate. Cinnamaldehyde extracted from *Cinnamomum zeylanicum* kills mites. The synthetic hormone—sold under the brand name *StirrupM*®—attracts spider mites, and is used very successfully to enhance miticides.

Chemical Insecticides and Miticides

Chemical	Trade Name*	Notes
<i>abamectin</i> soil	Avid®	Produced by fungi, <i>Streptomyces</i> species
<i>dienochlor</i>	Pentac®	Slow-acting but selective against mites
<i>aldicarb</i>	Temik®	Systemic miticide DO NOT USE
<i>methomyl</i>	Subdue®	Systemic insecticide DO NOT USE
<i>dicofol</i>	Kelthane®	Selective miticide, DDT relative, DO NOT USE
<i>acephate</i>	Orthene®	Systemic miticide/insecticide, DO NOT USE

*All trade names are not included. Check insecticides and miticides for chemical name.



Ants farm aphids. They move aphids to uninfected plants.

Aphids

Identify: Aphids, also called *plant lice*, are about the size of a pinhead. They are easy to spot with the naked eye, but use a 10X magnifying glass for positive identification. Aphids are found in all climates. Normally grayish to black, aphids can be green to pink—in any color, aphids attack plants. Most aphids have no wings, but those that do have wings are about four times the size of their bodies. Aphids give birth to mainly live female larvae, without mating, and can pump out 3 to 100 hungry larvae every day. Each female reproduces between 40 and 100 offspring that start reproducing soon after birth. Aphids are most common indoors when they are plentiful outdoors. Install yellow sticky traps near base of several plants and near the tops of other plants to monitor invasions of winged aphids, often the first to enter the garden. As they feed, aphids exude sticky honeydew that attracts ants that feed on it. Ants like honeydew so much that they take the aphids hostage and make them produce honeydew. Look for columns of ants marching around plants, and you will find aphids.

Damage: Aphids suck the life-giving sap from foliage causing leaves to wilt and yellow. When

infestation mounts, you may notice sticky honeydew excreted by aphids. They prefer to attack weak, stressed plants. Some species prefer succulent, new growth, and other aphids like older foliage or even flower buds. Look for them under leaves, huddled around branch nodes, and growing tips. This pest transports (vectors) bacterium, fungi, and viruses. Aphids vector more viruses than any other source. Destructive sooty mold also grows on honeydew. Any aphid control must also control ants, if they are present.

Controls: Manually remove small numbers. Spot-spray small infestations, and control ants. Introduce predators if problem is persistent.

Cultural and physical control: Manual removal is easy and works well to kill them. When affixed to foliage—sucking out fluid—aphids are unable to move and easy to crush with fingers or sponges dipped in an insecticidal solution.

Biological: Lacewings, *Chrysoperla* species, are the most effective and available predators for aphids. Release one to 20 lacewings per plant, depending on infestation level, as soon as aphids appear. Repeat every month. Eggs take a few days to hatch into larvae that exterminate aphids. Gall-midge, *Aphidoletes aphidimyza*, is available under the trade name Aphidend; parasitic wasp, *Aphidius matricaria*, is available commercially as Aphidpar.

Ladybugs also work well to exterminate aphids. Adults are easily obtained at many retail nurseries during the summer months. The only drawback to ladybugs is their attraction to the HID lamp—release about 50 ladybugs per plant, at least half of them will fly directly into the HID, hit the hot bulb, and buzz to their death. Within one or two weeks all the ladybugs will fall victim to the lamp, requiring frequent replenishment.

Verticillium lecanii (fungus)—available under the trade name of *Vertalec*®—is very aphid specific and effective.

Control ants by mixing borax hand soap or borax powder with powdered sugar. Ants eat the sweet mix and borax kills them. They excrete sweet borax mix in the nest where other ants eat the feces and die.

Sprays: Homemade and insecticidal soap sprays are very effective. Apply two or three times at five to ten day intervals. Pyrethrum (aerosol) applied two to three times at five to ten day intervals.

Bees and Wasps

Identify: Bees and wasps that sting are usually from a half inch (1.5 cm) to more than an inch (3 cm) long. Most have yellow stripes around their bodies and others have none. They are especially attracted to indoor gardens when weather cools outdoors— they move right in.

Damage: They cause no damage to plants but can become a nuisance in grow rooms and hurt like hell when they sting.

Controls: Occasionally a problem indoors, bees and wasps are most efficiently controlled with sprays.

Cultural and physical control: They enter grow rooms through vents and cracks, attracted by the growing plants, a valuable commodity in the middle of a cold winter! Screen all entrances to the room. Install more circulation fans to make flying difficult. Wasp traps, sweet flypaper, and Tanglefoot™ impair these pests. Bees and wasps are also attracted to the hot HID and fly into it and die.

Biological: Unnecessary.

Sprays: Pyrethrum is recommended. Stuff small nests into a wide-mouthed jar—do it at night when the wasps are quiet—and place the jar in a freezer for a few hours. Use Sevin, Carbaryl, only if there is a problem with a wasp nest.



Wasp Trap

their entry hole and dead growth on either side of the entry hole along the main stem, often discolored and accompanied by sawdust. Borers are more common outdoors than indoors.

Damage: Tunnels inside the stem and roots; curtails fluid flow, and causes plant parts to wilt. If borer damages the main stem severely, fluid flow to the entire plant could stop, causing death.

Controls: Seldom a problem indoors. Borers often cause so much damage on a particular stem that it has to be removed and destroyed.

Cultural and physical control: Handpick all beetle grubs.

Biological: Several mixes of beneficial nematodes control these borers in soil.

Sprays: *Bacillus popilliae* is specific to beetles or rotenone individually injected into stems.

Caterpillars and Loopers

Caterpillars and loopers leave plenty of droppings on the plant. The droppings accumulate in



This cocoon is attached to the bottom of a leaf.

Beetle Borers

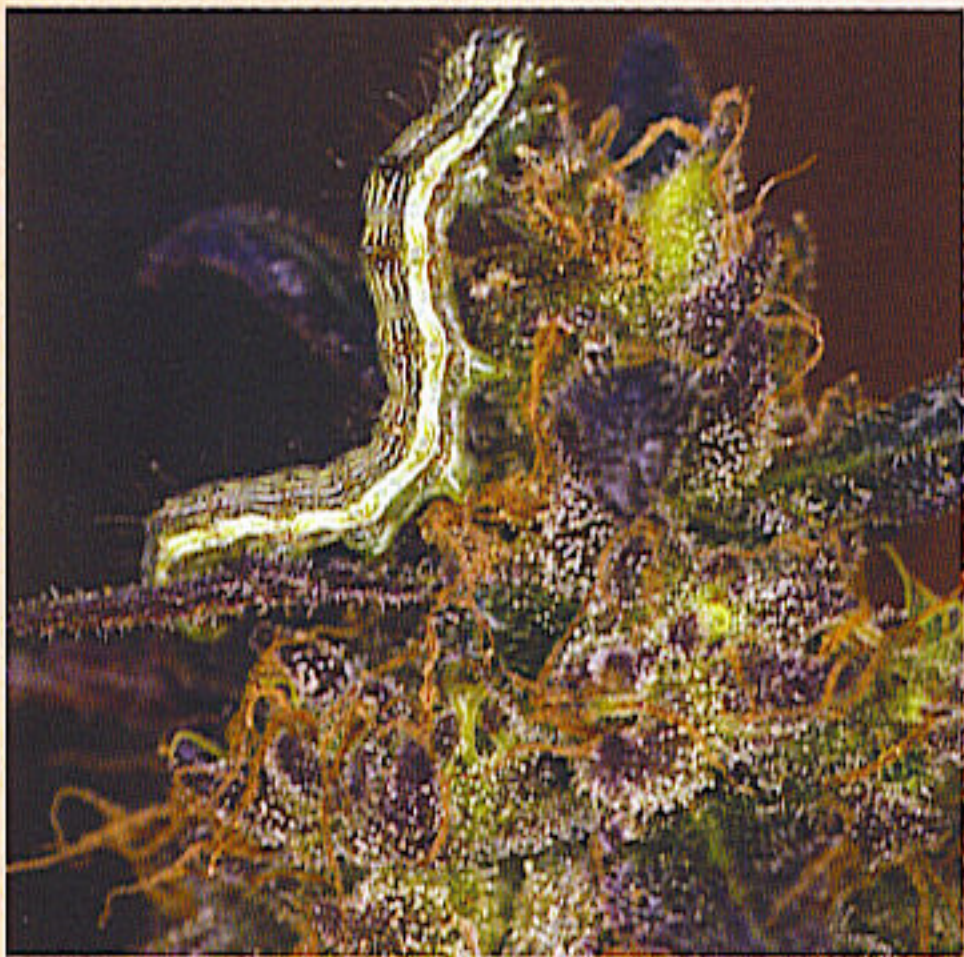
Identify: Larvae from several boring beetles tunnel or bore into stems and roots. Look for



Beetle Borer.



Caterpillars can cause major damage to foliage.



This caterpillar burrows into buds, leaving a wake of poop. The wound and feces both attract more diseases.



Cocoon attached to leaf.



Loopers arch their body upward to move forward.

between buds. Droppings fall out when the buds are hung to dry; inspect below the hung buds to find the poop droppings.

Identify: From half inch to four inches (1.5-10 cm), caterpillars and loopers are cylindrical with feet, often green, but can be virtually any color from white to black. Caterpillars have sets of feet the entire length of the body, while loopers have

two sets of feet at either end of the body. Loopers place their front feet forward, arch their body upward in the middle, and pull their rear sets of legs forward. Some have stripes, spots, and other designs that provide camouflage. Seldom a problem indoors, caterpillars and loopers are in a life stage—between a larva and a flying moth or butterfly—and are most common when prevalent outdoors. One way to check for caterpillars and loopers is to spray one plant with pyrethrum aerosol spray and shake the plant afterward. The spray has a quick knockout effect, and most caterpillars will fall from the plant.

Damage: These munching critters chew and eat pieces of foliage and leave telltale bites in leaves. Some caterpillars will roll themselves inside leaves. An infestation of caterpillars or leafhoppers will damage foliage and slow growth, eventually defoliating, stunting, and killing a plant.

Cultural and physical control: Manually remove.

Biological: *Trichogramma* wasps, spined soldier bug (*Podisus maculiventris* Podibug®).

Sprays: Homemade spray/repellent, hot pepper and garlic. *Bt*, pyrethrum, and rotenone

Leafhoppers

Identify: Leafhoppers include many small, 0.125 inch (3 mm) long, wedge-shaped insects that are usually green, white, or yellow. Many species have minute stripes on wings and bodies. Their wings peak like roof rafters when not in use. Leafhoppers suck plant sap for food and exude sticky honeydew as a by-product. Spittlebug and leafhopper larvae wrap themselves in foliage and envelop themselves in a saliva-like liquid, plant sap.

Damage: Stippling (spotting) similar to that caused by spider mites and thrips on foliage. Leaves and plant lose vigor, and in severe cases death could result.

Cultural and physical Control: Cleanliness! Black light traps are attractive to potato beetles.

Biological: The fungus, *Metarhizium anisopliae*, is commercially available under the trade name *Metaquino*®.

Sprays: Pyrethrum, rotenone, sabadilla.

Leaf Miner

Identify: Adult leaf miner flies lay eggs that hatch into one-eighth-inch (0.25 mm) long (green or black) maggots. You seldom see the maggots before you see the leaf damage they

create when they tunnel through leaf tissue. Leaf miners are more common in greenhouses and outdoors than indoors.

Damage: The tiny maggots burrow between leaf surfaces, leaving a telltale whitish-tunnel outline. The damage usually occurs on or in young supple growth. It is seldom fatal, unless left unchecked. Damage causes plant growth to slow, and if left unchecked, flowering is prolonged and buds are small. In rare cases the damage is fatal. Wound damage encourages disease.

Controls: These pests cause little problem to indoor crops. The most efficient and effective control is to remove and dispose of damaged foliage, which includes the rogue maggot, or to use the cultural and physical control listed below.

Cultural and physical control: Smash the little maggot trapped within the leaf with your fingers. If the infestation is severe, smash all larvae possible and remove severely infested leaves. Compost or burn infested leaves. Install yellow sticky traps to capture adults.

Biological: Branchid Wasp (*Dacnusa sibirica*), chalcid wasp (*Diglyphus isaea*), parasitic wasp (*Opius pallipes*).

Sprays: Repel with neem oil and pyrethrum sprays. Maggots are protected within tunnels, and sprays are often ineffective. *Hemp Diseases and Pests* suggests to water plants with a 0.5 percent solution of neem. This solution works fast and stays on plants for four weeks after application.

Fungus Gnat

Identify: Maggots, larvae, grow to 4-5 mm long and have translucent bodies with black heads. Winged adult gnats are gray to black, 2-4 mm long, with long legs. Look for them around the base of plants in soil and soilless gardens. They love the moist, dank environments in rockwool and the environment created in NFT-type hydroponic gardens. Adult females lay about 200 eggs every week to ten days.

Damage: Infests growing medium and roots near the surface. They eat fine root hairs and scar larger roots, causing plants to lose vigor and foliage to pale. Root wounds invite wilt fungi like *Fusarium* or *Pythium* especially if plants are nutrient-stressed and growing in soggy conditions. Maggots prefer to consume dead or decaying, soggy plant material; they also eat green algae



Leaf miner larvae burrow in the leaf. They cause few problems indoors and are most common outdoors in spring and early summer. Kill them by smashing them between your fingers.



Microscopic fungus gnats are difficult to see with the naked eye.



Scale affix themselves to stems and foliage. They are a minor problem indoors and outdoors.



This nematode attacked the stem. Most often nematodes attack roots. Large knots grow where nematodes damage both roots and stems.

growing in soggy conditions. Adults and larvae can get out of control quickly, especially in hydroponic systems with very moist growing mediums. The adult gnats stick to resinous buds like *flypaper*! The gnats are very difficult to clean from the buds.

Controls: The easiest way to control these pests is with Vectobac®, Gnatrol®, and Bactimos®, all contain *Bacillus thuringiensis* var. *israelensis* (Bt-i). This strain of Bt controls the maggots; unfortunately, it is available only in large one-gallon (3.8 L) containers. Difficult to find at garden centers, check hydroponic stores.

Cultural and physical control: Do not overwater, and keep ambient humidity low. Do not let growing medium remain soggy. Cover growing medium so green algae won't grow. Yellow sticky traps placed horizontally 1-2 inches (3-6 cm) over growing medium catches adults.

Biological: The aforementioned Bt-i works best. Alternatives include the predatory soil mite (*Hypoaspis* (Geolaelapumites) and the nematode (*Steinernema feltiae*).

Sprays: Apply neem or insecticidal soap as a soil-drench.

Mealybugs and Scales

Mealybugs:

Identify: Somewhat common indoors, these 0.08-0.2 inch (2-7 mm) oblong, waxy-white insects move very little, mature slowly, and live in colonies that are usually located at stem joints. Like aphids, mealybugs excrete sticky honeydew.

Scales:

As uncommon indoors as mealybugs, scale looks and acts similar to mealybugs but is usually more round than oblong. Scales may be white, yellow, brown, gray, or black. Their hard protective shell is 0.08-0.15 inch (2-4 mm) across. Mealybugs rarely or never move. Check for them around stem joints where they live in colonies. Scales sometimes excrete sticky honeydew.

Damage: These pests suck sap from plants which causes growth to slow. They also exude sticky honeydew as a by-product of their diet of plant sap which encourages sooty mold and draws ants that eat the honeydew.

Controls: These pests present little problem to indoor growers. The easiest and most efficient control is listed under *Cultural and physical* below.

Cultural and physical control: Manual removal is somewhat tedious but very effective. Wet a Q-Tip in rubbing alcohol and wash scale away. A small knife, fingernails, or tweezers may also be necessary to scrape and pluck the tightly affixed mealybugs and scales after they are Q-Tipped with alcohol.

Biological: There are numerous species of mealybugs and scales. Each has natural predators including species of ladybeetles (ladybugs) and parasitic and predatory wasps. There are so many species of each that it would be exhaustive to list them here. For more specific information see *Hemp Diseases and Pests*.

Sprays: Homemade sprays that contain rubbing alcohol, nicotine, and soaps all kill these pests. Insecticidal soap, pyrethrum, and neem oil are all recommended.

Nematodes

Identify: Of the hundreds and thousands of species of microscopic nematodes—sometimes, big ones are called *eelworms*—a few are destructive to plants. Most often nematodes attack roots and are found in the soil; however, a few nematodes attack stems and foliage. Root nematodes can often be seen in and around roots with the help of a 30X microscope. Often growers just diagnose the damage caused by destructive nematodes rather than actually seeing them.

Damage: Slow growth, leaf chlorosis, wilting several hours during daylight hours from lack of fluid flow—symptoms can be difficult to discern from nitrogen deficiency. Root damage is often severe by the time they are examined. Root knot nematodes are some of the worst. They cause roots to swell with galls. Other nematodes scrape and cut roots, compounded by fungal attacks. Roots turn soft and mushy.

Cultural and physical control: Cleanliness! Use new, sterilized potting soil or soilless mix to exclude nematodes entrance. Nematodes rarely cause problems indoors in clean grow rooms.

Biological: French marigolds, *Tagetes patula*, repels soil nematodes, fungus (*Myrothecium ver-rucaria*, trade name DeTera ES®)

Sprays: Neem used as a soil-drench.

Root Maggot

Identify: Both the seed corn maggot and the cabbage maggot attack cannabis roots. The seed corn maggot is 1.5 to 2 inches (5-6 cm) long. The seed corn maggot converts into a fly and is a bit smaller than a common housefly. Cabbage maggots are 0.3 inch (1 cm) long, and the adult fly is bigger than a housefly. These pests winter over in the soil and live in unclean soil. In the spring, they emerge as adult flies and soon lay eggs in the soil at the base of young plants. The squirmy, whitish larvae hatch several days later with a ravenous appetite.

Damage: Root maggots chew and burrow into stems and roots. The seed corn maggot attacks seeds and seedling roots. Cabbage maggots attack roots, leaving hollowed out channels and holes in larger roots. Both maggots destroy small hair-like feeder roots. Wounds made by the root maggots also foster soft rot and fungal diseases.

Cultural and physical control: Cleanliness! Use fresh, new store-bought soil when planting in containers. Cover seedlings with Agronet® to



Root knot nematodes cause roots to develop lumps. Fluid flow from roots causes impaired growth.

exclude flies, and plant late in the year to avoid most adult flies. Place a collar 18-inch (45 cm) of foam rubber around the base of the plant to exclude flies.

Biological: Control with parasitic nematodes, *Steinernema feltiae* or *Heterorhabditis bacteriophora*.

Sprays: Kill root maggots with neem and horticultural oil used as a soil-drench.

Slugs and Snails

Identify: Slugs and snails are soft, slimy white, dark, or yellow, and occasionally striped. They are 0.25-3 inches (1-9 cm) long. Snails live in a circular shell, slugs do not. They hide by day and feed at night. Slugs and snails leave a slimy, silvery trail of mucus in their wake. They lay translucent eggs that hatch in about a month. They reproduce prolifically, and the young mollusks often eat relatively more than adults.

Damage: They make holes in leaves often with a web-like appearance. They will eat almost any vegetation, roots included. These creatures winter over in warm, damp locations in most climates. Slugs and snails especially like tender seedlings. They will migrate to adjacent gardens in quest of food.

Cultural and physical control: A clean, dry perimeter around the garden will make it difficult for them to pass. Spotlight and handpick at night. A thin layer of lime, diatomaceous earth, or salty beach sand two to six (6-15 cm) inches wide around individual plants, beds, or the entire garden will present an impassable barrier. The lime is not thick enough to alter the pH and will repel



Root maggots are found in contaminated soil. They gnaw off root hairs and hollow out larger roots.



Slugs and snails cause most damage to seedlings outdoors. Look for slime trails and holes in leaves to help identify the pests.



Thrips make light abrasions on leaf surfaces.

or dissolve pests. To trap, attach short one inch (3 cm) feet on a wide board and leave it in the garden. The pests will seek refuge under the board. Pick up the board every day or two, and shake the slugs off and step on them.

Poisonous baits usually have metaldehyde as a base. Confine the bait to a slug hotel. Cut a 1 x 2-inch (3-6 cm) slot in a covered plastic container to make a slug and snail hotel. Place slug and snail bait inside the hotel. The hotel must keep the bait dry and off the soil. In a slug hotel, none of the poison bait touches the soil, and the bait is inaccessible to children, pets, and birds. Place slug and snail hotels in out of the way places. Natural baits include a mix of jam and water and beer. If using beer, it must be deep enough to drown mollusks.

Biological: The predatory snail, *Rumina decollata*—available commercially—is yet another way to combat plant-eating slugs and snails.

Sprays: Young slugs and snails are not attracted to bait. Spray for young at night or early morning with a 50 percent ammonia-water solution.

Thrips

Identify: More common in greenhouses than indoors. These tiny, winged, fast moving little critters are hard to see but not hard to spot. From 0.04-0.05 inch (1-1.5 mm) long, thrips can be different colors, including white, gray, and dark colors, often with petite stripes. Check for them under leaves by shaking parts of the plant. If there are many thrips present, they choose to jump and run rather than fly to safety. But often you will see them as a herd of specks thundering across foliage. Females make holes in soft plant tissue where they deposit eggs that are virtually invisible to the naked eye. Winged thrips easily migrate from infested plants to the entire garden.

Damage: Thrips scrape tissue from leaves and buds, afterward sucking out the plant juices for food. Stipples—whitish-yellowish specks—appear on top of leaves; chlorophyll production diminishes and leaves become brittle. You will also see black specks of thrip feces and little thrips. Many times thrips feed inside flower buds or wrap-up and distort leaves.

Cultural and physical control: Cleanliness! Blue or pink sticky traps, misting plants with water impairs travel. Manual removal works okay if only a few thrips are present, but they are hard to catch. Thrips can be very vexing to control once they get established.

Biological: Predatory mites (*Amblyseius cucumeris* and *Amblyseius barkeri*, *Neoseiulus cucumeris*, *Iphiseius degenerans*, *Neoseiulus barkeri*, *Euseius hibisci*), parasitic wasps (*Thripobis semiluteus*, *Ceranisus menes*, *Goetheana shake-spearei*), pirate bugs (*Orius* species), fungus, *Verticillium lecanii*, is effective.

Sprays: Homemade sprays such as tobacco-nicotine base; commercial pyrethrum, synthetic pyrethrum, insecticidal soap. Apply two to four times at five to ten day intervals.

Whiteflies

Identify: The easiest way to check for the little buggers is to grab a limb and shake it. If there are any whiteflies, they will fly from under leaves. Whiteflies look like a small, white moth about 0.04-inch (1 mm) long. Adult whiteflies have wings. They usually appear near the top of the weakest plant first. They will move downward on the plant or fly off to infest another plant. Eggs are also found on leaf underside, where they are connected with a small hook.

Damage: Whiteflies, like mites, may cause white speckles, stipples, on the tops of leaves. Loss of chlorophyll production and plant vigor diminishes as infestation progresses.

Cultural and physical control: Mites are difficult to remove manually because they fly. Adults are attracted to the color yellow. To build a whitefly trap similar to flypaper, cover a bright, yellow object with a sticky substance like Tanglefoot™. Place the traps on the tops of the pots among the plants. Traps work very well. When they are full of insects, toss them out.

Biological: The wasp, *Encarsia formosa*, is the most effective whitefly parasite. The small wasps only attack whiteflies, they do not sting people! All toxic sprays must be washed completely off before introducing parasites and predators. Since the *Encarsia formosa* is a parasite, about 0.125 inch (3 mm) long, smaller than the whitefly, it takes them much longer to control or even keep the whitefly population in check. The parasitic wasp lays an egg in the whitefly larva that later hatches and eats the larva alive, from the inside out—death is slow. If you use them, set them out at the rate of two or more parasites per plant as soon as the first whitefly is detected. Repeat every two to four weeks throughout the life of the plants.



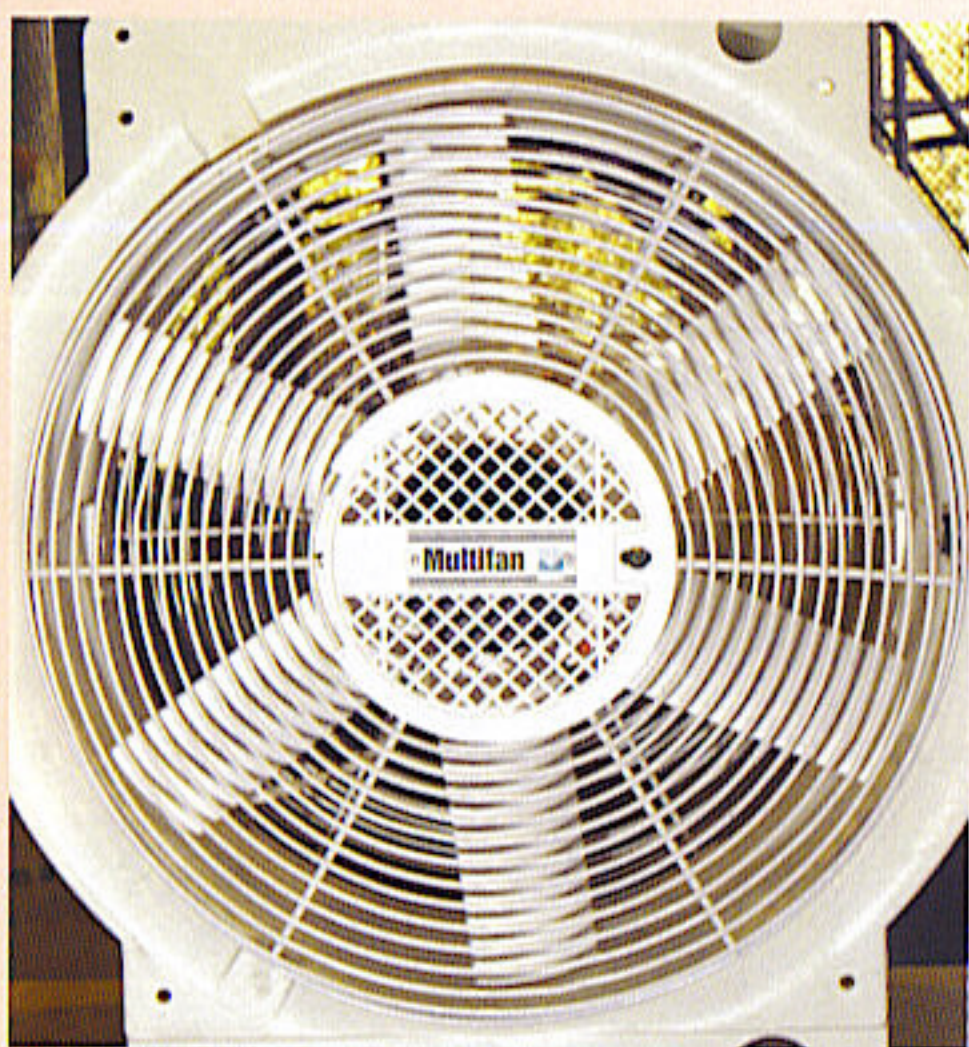
Whiteflies can be seen in between yellowish aphids. Dark spots are honeydew that has started to mold.

The fungus *Verticillium lecanii* AKA *Cephalosporium lecanii*, trade name Mycatol®, is also very effective in whitefly control.

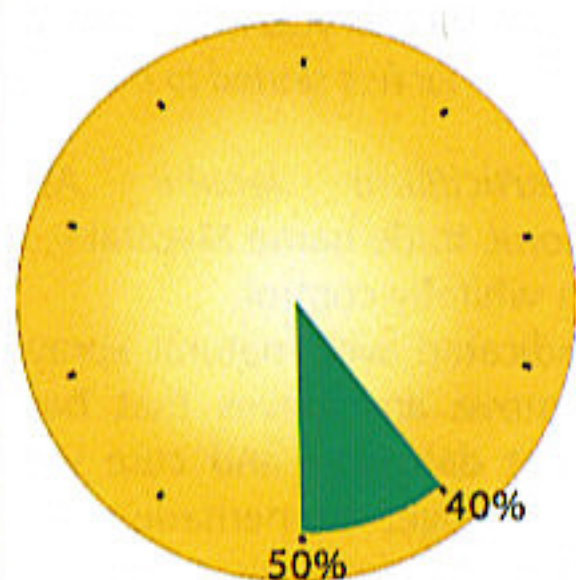
Sprays: Easily eradicated with natural sprays. Before spraying, remove any leaves that have been over 50 percent damaged and cure with heat or burn infested foliage. Homemade sprays applied at five to ten day intervals work well. Insecticidal soap applied at five to ten day intervals. Pyrethrum (aerosol) applied at five to ten day intervals.

Fungi and Diseases

Fungi are very primitive plants and do not produce chlorophyll, the substance that gives higher plants their green color. Fungi reproduce by spreading tiny microscopic spores rather than seeds. Countless fungal spores are present in the air at all times. When these microscopic-airborne spores find the proper conditions, they will settle, take hold, and start growing. Some fungi, such as bud-rotting gray mold (*Botrytis*) are so prolific that they can spread through an entire crop in a matter of days! In fact, one grow room was located near a swamp and *Botrytis* spores were omnipresent in the environment. Buds and stems contracted gray mold quickly and were



A good vent fan is essential to control humidity indoors.



Fungus Grows Poorly at 40 - 50% Relative Humidity

In general, most fungus does not grow or grows poorly when relative humidity stays between 40 and 50 percent.

often reduced to a wisp-of-powdery-foliage in short order. The grower lost four consecutive crops. Finally, the grower moved to greener pastures and had no trouble with mold. Unsterile, soggy soil, coupled with humid, stagnant air, provides the environment most fungi need to thrive. Although there are many different types of fungi, they are usually prevented with similar methods.

Prevention

Prevention is the first step and the true key to fungi control. The section "Setting up the Grow Room" instructs growers to remove

anything—cloth curtains, clothes, and other debris—that might attract, harbor, and spread fungi. Cover the carpet with white Visqueen® plastic. If mold should surface on the walls, spray with fungicide. Wash walls with a five percent bleach solution or Pinesol® (made from natural pine oil) and apply paint that contains a fungus-inhibiting agent. Specially designed paints for damp conditions contain a fungicide and are attracted by moisture. When applied to a damp, cracked basement wall, the paint is drawn into the moist crack. Remove all mold from the walls by washing it with a bleach solution before painting with fungus-resistant paint. Cleanliness and climate control are the keys to preventing fungi. Few clean, well ventilated grow rooms have problems with fungi. In contrast, every dingy, dank, ill-kept indoor garden I have seen had fungal problems and yielded a substandard harvest.

Install a vent fan(s) large enough to remove moist air quickly and keep humidity at 50 percent or less. A vent fan is the easiest and least expensive humidity control device available. CO₂ generators produce humidity-increasing water vapor as a by-product. Dehumidifiers are relatively inexpensive, readily available at discount stores, and do a good job of keeping humidity under control in enclosed grow rooms. Dehumidifiers draw extra electricity, and the condensed water must be removed daily. Wood, coal, and electric heat all dry and dehumidify the air. Most air conditioners can be set to a specific humidity level. If the grow room(s) have a central heating/air-conditioning vent, the vent can be opened to control temperature and lower humidity.

Control

Prevent fungus by controlling all the factors contributing to its growth: remove hiding places, keep room clean, lower humidity to 50 percent, and keep the air well-circulated. If prevention proves inadequate and fungi appear, advanced control measures are necessary. Carefully remove and destroy dead leaves. Wash your hands after handling diseased foliage. If the problem attacks one or a few plants, isolate and treat them separately. Remember, fungi can spread like wildfire if the conditions are right. If they get a good start even after all preventive measures are taken, do not hesitate to take extreme control methods including spraying the entire garden with the proper fungicide.

Logical Progression of Fungus Control

Prevention
Cleanliness
Low humidity
Ventilation
Removal
Copper, lime sulfur sprays
Specific fungicide

Gray Mold (*Botrytis*), a.k.a. Bud Mold

Identify: Gray mold is the most common fungus that attacks indoor plants and flourishes in moist temperate climates common to many grow rooms. *Botrytis* damage is compounded by humid (above 50 percent) climates. It starts within the bud and is difficult to see at the onset—grayish-whitish to bluish-green in color—*Botrytis* appears hair-like and similar to laundry lint in moist climates. As the disease progresses, the foliage turns somewhat slimy. Damage can also appear as dark, brownish spots on buds in less humid environments. Dry to the touch, *Botrytis*-affected area often crumbles if rubbed. Gray mold attacks countless other crops, and airborne spores are present virtually everywhere. While most commonly found attacking dense and swelling flower buds, it also attacks stems, leaves, and seeds, causes damping-off, and decomposes dry, stored bud. It is also transmitted via seeds.

Damage: Watch for single leaves that mysteriously dry out on the buds. They could be the tell-tale signs of a *Botrytis* attack inside the bud. Constant observation, especially during the last two weeks before harvest, is necessary to keep this disease out of the garden. Flower buds are quickly reduced to slime in cool, humid conditions or un-smokable powder in warm, dry rooms. *Botrytis* can destroy an entire crop in seven to ten days if left unchecked. Stem damage—*Botrytis* starts on stems and not buds—is less common indoors. First, stems turn yellow and cankerous growths develop. The damage causes growth above the wound to wilt and can cause stems to fold over. Transported by air, contaminated hands, and tools, gray mold spreads very quickly indoors, infecting an entire grow room in less than a week when conditions are right.



Botrytis, also known as bud mold, attacks both buds and stems of plants.



Botrytis on this plant progressed from the bud down the stem.



This bud is covered with Botrytis. It was removed from the garden and destroyed.



Evaporated sulfur in a grow room or greenhouse stops *Botrytis* from contaminating plants.



Damping-off attacked this stem at the soil line, rotting the buried end of the stem.

Control: Minimize *Botrytis* attack incidence with low humidity (50 percent or less), ample air circulation, and ventilation. Grow varieties that do not produce heavy, tightly packed buds that provide a perfect place for this fungus to flourish. Cool (below 70°F [21°C]), moist climates with humidity above 50 percent are perfect for rampant gray mold growth. Remove dead leaf stems, petioles, from stalks when removing damaged leaves to avoid *Botrytis* outbreaks, which is

often harbored by dead, rotting foliage. Increase ventilation and keep humidity below 60 percent, and keep the grow room clean! Use fresh, sterile growing medium for each crop.

Cultural and physical control: As soon as *Botrytis* symptoms appear, use alcohol-sterilized pruners to remove *Botrytis*-infected buds at least one inch (3 cm) below the infected area. Some growers amputate two to four inches (5-10 cm) below damage to ensure removal. Do not let the bud or anything that touches it contaminate other buds and foliage. Remove from the garden and destroy. Wash your hands and tools after removing. Increase temperature to 80°F (26°C) and lower humidity to below 50 percent. Excessive nitrogen and phosphorus levels make foliage tender, so *Botrytis* can get a foothold. Make sure pH is around 6 to facilitate calcium uptake. Low light levels also encourage weak growth and gray mold attack. Avoid heavy crowding of plants and keep the light levels bright. *Botrytis* needs UV light to complete its life cycle; without UV light it cannot live. Some varieties seldom fall victim to gray mold. Many crosses are more resistant to gray mold than pure *indica* varieties. Harvest when resin glands are still translucent. Once glands turn amber, threat of gray mold increases substantially.

Biological: Spray plants with *Gliocladium roseum* and *Trichoderma* species. Prevent damping-off with a soil application of *Gliocladium* and *Trichoderma* species. *Hemp Diseases and Pests* suggests to experiment with the yeasts *Pichia guilliermondii* and *Candida oleophila* or the bacterium *Pseudomonas syringae*.

Sprays: Bordeaux mixture keeps early stages of *Botrytis* in check as long as it is present on the foliage. Preventive spraying is advised if in a high-risk area, but spraying buds near harvest-time is not advised. Seeds are protected from *Botrytis* with a coating of Captan. Check with your local nursery for product recommendations.

Damping-off

Identify: This fungal condition, sometimes called *Pythium* wilt, is often found in soil and growing mediums. It prevents newly sprouted seeds from emerging, and attacks seedlings causing them to rot at the soil line, yellows foliage and rots older plants at soil line. It occasionally attacks rooting cuttings at the soil line, too. It is

caused by different fungal species, including *Botrytis*, *Pythium*, and *Fusarium*. Once initiated, damping-off is fatal. At the onset of damping-off, the stem loses girth at the soil line, weakens, then grows dark, and finally fluid circulation is cut, killing the seedling or cutting.

Control: Damping-off is caused by a combination of the following: (1) Fungi are already present in an unsterile rooting medium; (2) Overwatering and maintaining a soggy growing medium; (3) Excessive humidity. The disease can be avoided by controlling soil moisture. Overwatering is the biggest cause of damping-off and the key to prevention. Careful daily scrutiny of soil will ensure the proper amount of moisture is available to seeds or cuttings. Start seeds and root cuttings in a fast-draining, sterile coarse sand, rockwool, Oasis™, or Jiffy™ cubes, which are difficult to overwater. Do not place a humidity tent over sprouted seedlings—a tent can lead to excessive humidity and damping-off. Cuttings are less susceptible to damping-off and love a humidity tent to promote rooting. Keep germination temperatures between 70-85°F (21-29°C). Damping-off is inhibited by bright light; grow seedlings under the HID rather than fluorescent bulbs. Keep fertilization to a minimum during the first couple weeks of growth. Germinate seeds between clean, fresh paper towels and move seeds to soil once sprouted. Do not plant seeds too deeply, cover with soil the depth of the seed. Use fresh, sterile growing medium and clean pots to guard against harmful fungus in the soil.

Biological: Apply Polygangron® (*Pythium oligandrum*) granules to soil and seed. Bak Pak® or Intercept® are applied to the soil and Deny® or Dagger®—forms of the bacterium *Burkholderia cepacia*—are put on the seeds. Epic®, Kodiak®, Quantum 4000®, Rhizo-Plus®, System 3®, and Serenade® also suppress many causes of damping-off.

Chemical: Dust the seeds with Captan®. Avoid benomyl fungicide soil drench because it kills beneficial organisms.

Downy Mildew

Identify: Sometimes called *false mildew*, downy mildew affects vegetative and flowering plants. Young, succulent foliage is a favorite starting place. Powdery mildew develops in temperatures below 76°F (26°C).



A small, white spot and the beginning of rot at the soil line are the first visual signs of damping-off.



Lack of oxygen caused by overwatering impairs root development along the stem and contributes to damping-off.



Powdery mildew, fuzzy white spots signify the disease already permeates the entire plant. Climate control will prevent powdery mildew.



Foliar spots started on this leaf after it became severely nitrogen-deficient.

It appears as whitish-yellow spots on top of leaves creating pale patches. Grayish mycelium spawn is on leaf undersides, opposite the pale patches. Downy mildew can spread very quickly, causing a lack of vigor and slow growth; leaves yellow, die back, and drop. The disease is in the plant system and grows outward. It is often fatal, spreads quickly, and can wipeout a crop. Avoid promoting this disease by not crowding plants. Keep temperatures above 76°F (26°C) and the humidity below 50 percent.

Control: Cleanliness! Use sterile growing medium. Remove and destroy affected plants, not just foliage.

Biological: Apply Serenade® (*Bacillus subtilis*). Bordeaux mixture is also somewhat effective.

Blight

Identify: Blight is a general term that describes many plant diseases which are caused by fungus, most often a few weeks before harvest. Signs of blight include dark, blotchy spots on foliage, slow growth, sudden yellowing, wilting, and plant death. Most blights spread quickly through large areas of plants.

Control: Cleanliness! Use fresh, sterile growing medium. Avoid excess nitrogen fertilization. Avoid blights by keeping plants healthy with the proper nutrient balance and good drainage to prevent nutrient buildup.

Biological: Use Serenade® (*Bacillus subtilis*) against Brown Blight. Use Binab®, Bio-Fungus®, RootShield®, Supresivit®, Trichopel®, (*Trichoderma harzianum*) or SoilGuard® (*Trichoderma virens*). Use a Bordeaux mixture to stop fungal blights. Stopping blights in advanced

stages is difficult; the best solution is to remove diseased plants and destroy them.

Foliar Spots and Fungi

Identify: Leaf and stem fungi, including leaf spot, attack foliage. Brown, gray, black, or yellow to white spots or blotches develop on leaves and stems. Leaves and stems discolor and develop spots that impair plant fluid flow and other life processes. Spots expand over leaves causing them to yellow and drop. Growth is slowed, harvest prolonged, and in severe cases, death results. Leaf spot is the symptomatic name given to many diseases. These diseases may be caused by bacteria, fungus, and nematodes. Spots or lesions caused by fungi often develop different colors as fruiting bodies grow. Leaf spots are often caused by cold water that was sprayed on plants under a hot HID. Temperature stress causes the spots that often develop into a disease.

Control: Cleanliness! Use fresh, sterile growing medium with each crop. Move HIDs away from the garden canopy about 30 minutes before spraying so plants won't be too hot. Do not spray within four hours of turning the lights off as excess moisture sits on the foliage and fosters fungal growth. Do not wet foliage when watering, avoid overwatering, and lower grow room humidity to 50 percent or less. Check the humidity both day and night. Employ dry heat to raise the nighttime temperature to 5-10°F (3-6°C) below the daytime levels, and keep humidity more constant. Allow adequate spacing between plants to provide air circulation. Remove damaged foliage. Avoid excessive nitrogen application.

Biological: Bordeaux mixture may help keep leaf spots in check, but it is often phytotoxic when applied regularly indoors.

Sprays: Bordeaux mixture.

Fusarium Wilt

Identify: Fusarium wilt is most common in warm grow rooms and greenhouses. Recirculating nutrient solutions above 75°F (24°C) creates perfect conditions for fusarium. The water and nutrient solution carries this disease with it when contaminated. Fusarium starts as small spots on older, lower leaves. Interveinal leaf chlorosis appears swiftly. Leaf tips may curl before wilting and suddenly drying to a crisp. Portions of the plant or the entire plant will wilt. The entire process happens so fast that yellow,

dead leaves dangle from branches. This disease starts in the plant's xylem, the base of the fluid transport system. Plants wilt when fungi plug the fluid flow in plant tissue. Cut one of the main stems in two, and look for the telltale reddish-brown color.

Control: Cleanliness! Use fresh, clean growing medium. Avoid nitrogen over-fertilization.

Preventive action is necessary. Keep nutrient solution below 75°F (24°C). Hydrogen peroxide infusions will also arrest fusarium. Always remove infested plants and destroy.

Biological: Mycostop® (*Streptomyces griseoviridis*), or Deny®, or Dagger® (*Burkholderia cepacia*) and *Trichoderma*.

Sprays: Treat seeds with chemical fungicides to eradicate the seed-borne infection. Chemical fungicides are not effective on foliage.

Green Algae

Identify: Slimy green algae need nutrients, light, and a moist surface on which to grow. These algae are found growing on moist rockwool and other growing mediums exposed to light. They cause little damage but attract fungus gnats and other critters that damage roots. Once roots have lesions and abrasions, diseases enter easily.

Control: Cover the moist rockwool and growing mediums to exclude light. Run an algaecide in the nutrient solution or water with an algaecide.

Powdery Mildew

Identify: First indication of infection is small spots on the tops of leaves. At this point the dis-



Fusarium wilt causes the center of the stem to turn reddish-brown in color.

ease has been inside the plant a week or more. Spots progress to a fine, pale, gray-white powdery coating on growing shoots, leaves, and stems. Powdery mildew is not always limited to the upper surface of foliage. Growth slows, leaves yellow, and plants die as the disease advances. Occasionally fatal indoors, this disease is at its worst when roots dry out and foliage is moist. Plants are infected for weeks before they show the first symptoms.

Control: Cleanliness! Prevent this mildew by avoiding cool, damp, humid, dim grow room conditions, as well as fluctuating temperatures and humidity. Low light levels and stale air affect this disease. Increase air circulation and ventilation, and make sure light intensity is high. Space containers far enough apart so air freely flows between plants. Allow foliage to dry before turning off lights. Remove and destroy foliage more than 50 percent infected. Avoid excess nitrogen. Copper and sulfur-lime sprays are a good prophylactic.

Biological Control: Apply Serenade® (*Bacillus subtilis*) or spray with a saturation mix of baking soda and water.

Sprays: Bordeaux mixture may keep this mold in check. A saturation of baking soda spray dries to a fine powder on the leaf; the baking soda changes the surface pH of the leaf to 7, and powdery mildew cannot grow.

Root Rot

Identify: Root rot fungi cause roots to turn from a healthy white to light brown. As the rot progresses, roots turn darker and darker brown. Leaf chlorosis is followed by wilting of the older leaves on the entire plant, and its growth slows. When severe, rot progresses up to the base of the plant stock, turning it dark. Root rot is most common when roots are deprived of oxygen and stand in un-aerated water. Soil pests that cut, suck, and chew roots create openings for rotting diseases to enter. Inspect roots with a 10X magnifying glass for signs of pest damage.

Control: Cleanliness! Use fresh, sterile growing medium. Make sure calcium levels are adequate, and do not overfertilize with nitrogen. Keep pH above 6.5 in soil and about 6.0 in hydroponic mediums to lower disease occurrence. Control any insects, fungi, bacteria, etc., that eat roots.

Biological: Binab®, Bio-Fungus®, RootShield®, Supresivit®, Trichopel®



Rotten roots have been soaking in stagnant nutrient solution. Foliage is very slow to grow when roots are rotten!

(*Trichoderma harzianum*), or SoilGuard® (*Trichoderma virens*).

Sprays: Sprays are not effective.

Pythium Wilt/Rot

Identify: (See Damping-off above.)

Sooty Mold

Identify: Black sooty mold is a surface fungus that grows on sticky honeydew excreted by aphids, mealybugs, scale, whiteflies, etc. Sooty mold is only a problem on indoor plants when honeydew is present. Sooty mold restricts plant development, slows growth, and diminishes harvest.

Control: Remove insects that excrete honeydew. Once honeydew is controlled, mold dies. Wash away honeydew and mold with a biodegradable soapy solution. Rinse away soapy water a few hours after applying.

Verticillium Wilt

Identify: Lower leaves develop chlorotic yellowing on margins and between veins before turning dingy brown. Plants wilt during the day and recoup when the light goes off. Wilt soon over-

Right: Verticillium wilt is less common than fusarium wilt, but the symptoms are similar. Cut a stem and look for discolored xylem.

comes parts of the plant or the entire plant. Cut the stem in two and look for the telltale brownish xylem tissue. The fungus blocks the flow of plant fluids, causing wilting.

Control: Cleanliness! Use fresh, sterile soil. Good drainage. Use amonical nitrogen as a source of nitrogen. Do not overfertilize.

Biological: Bio-Fungus® (*Trichoderma* species), Rhizo-Plus® (*Bacillus subtilis*).

Sprays: No chemical spray is effective.



Viruses

Identify: Viruses are still a mystery. They act like living organisms in some instances and nonliving chemicals in other cases. They must enter plants via wounds. Once a virus takes over plant cells, it is able to multiply. Viruses are spread by insects, mites, plants, animals, and human vectors. Aphids and whiteflies are the worst. Infected tools also transport viruses from one plant to another. Typical symptoms of viral infection are: sickly growth, leaf and stem spots, yellowing, and low yields. Viral diseases move into the plant's fluid distribution system and destroy it, which often cause leaf spots and mottling. A virus can completely take over a plant in a few days. Once a plant gets a virus, there's little you can do.

Control: Cleanliness! Always use fresh, sterile growing medium. Disinfect tools before cutting foliage on different plants. Destroy all plants infected with virus.

Biological: None.

Sprays: No chemical sprays are effective against viruses.



Troubleshooting

This simple troubleshooting chart will solve 90 percent of the grow problems encountered when growing cannabis. This chart started with an article in *High Times* magazine and borrowed from the "Problem Identification Keys" presented in *Hemp Diseases and Pests: Management and Biological Control*, by J. M. McPartland, R. C. Clarke, D. P. Watson.. Please see that book for much, much more information. One word of caution—this troubleshooting chart assumes the grow room is clean.

Clones are relatively easy to root. Success rate depends on the proper combination of heat, humidity, light, rooting hormone, and growing

medium aeration/moisture. The more precise the combination, the faster and stronger roots grow.

The vegetative growth stage is when problems begin to show. Often, these problems continue through flowering. Remedy problems before they progress. If allowed to persist through flowering, yield will be substantially diminished.

Flowering is the last stage in life and only six to ten weeks long. Problems must be solved within the first two weeks (at the absolute latest, three weeks) of flowering, or yields decrease in relation to the severity of the problems.

Note: Keep growing area super clean to help prevent problems. If you notice insects or fungus on foliage, remove them and check them against color photos and drawings in this book and the troubleshooting chart below.

Troubleshooting Chart		
Growth Stage	Cause	Quick Fix
Seeds and Seedlings Seeds do not germinate	Damping off Bad seed	Buy new seed, start over Get your money back!
	Root maggots	Drench soil with neem or horticultural oil
Seed germinates, seedling has signs of pests eating/sucking foliage	Spider mites (stippled leaves) Aphids (exude honeydew)	Spray neem oil pyrethrum Spray pyrethrum, insecticidal soap, or nicotine sulfate
Seedling stem at base has dark or sickly growth, suddenly falls over, or suddenly wilts	Damping off	Drench soil with metalaxyl or buy new seeds
	Damping off or a wilt disease Too much or too little moisture	Uncommon in clones Correct accordingly
Seedling leaves have yellow, gray, black, and/or dark green (fungus-like) spots	Blight or anthracnose	Remove growing plants and growing medium
Continued on next page:		

Clones

Wilt and die

Lack of moisture

Add humidity dome,
mist 4-6 times daily

Wilt and die

Medium too wet

Drain medium, do not
water, no standing
water in tray

Won't root

Medium too dry or
too wet

See "Wilt and die"
see above

Inconsistent rooting
hormone

Change to liquid or
gel rooting hormone

Vegetative stage

Leggy, weak plants

Lack of light

Add lamp, change
reflector, move lamp
closer to plants

Leggy, weak plants

Lack of ventilation,
Soil too wet
Soil too dry
Toxic nutrient buildup

Add vent fan
Irrigate less
Irrigate more
Leach grow medium*
change nutrient solution

Stunted, stubby plants

Insect damage
Rotten roots
Toxic nutrient buildup

Spray pyrethrum**
Irrigate less
Leach grow medium*

Burned leaf tips
Purple stems & burned
leaf spots

Toxic nutrient buildup-
Could be one of many
different nutrients

Leach medium* weekly
Lower nutrient dose &
leach medium* weekly

Leaf spots, margins burned,
discolored leaves, pale leaves

Nutrient toxicity

Leach medium*, change
nutrient solution,
change fertilizer, refer to
specific nutrient problems

Small, whitish spots on leaves

Spider mite damage

Spray pyrethrum**, neem
oil

Insect damage-chewed leaves,
insects/eggs visible on plants-
check under leaves with 20X loop.

Whiteflies, aphids, scale,
caterpillars, larva, etc.

Spray pyrethrum** or
neem oil

Fungus or mold on foliage or soil

High humidity (above 60%)
High temperature (above 80°F)

Add vent fan
Add vent fan
Spray soil with 5% bleach
solution and wash off next
day. Spray foliage with
10% baking soda solution

Severe, sudden wilting of plant	Fusarium or verticillium wilt Lack of water	Remove plant & growing medium and destroy Irrigate plant, submerge roots in water
Flowering Slow growth and small buds cooked or rotten roots	Over-fertilized, water/light/air-stressed,	Leach* grow medium Add big/more vent fans Keep grow medium evenly moist. The closer to harvest, the less that can be done. Must remedy three to six weeks before harvest for results.
Older leaf discoloration and dieback	Nitrogen, potassium, phosphorus, or zinc deficiency	See specific nutrient for solution
New leaf discoloration and dieback	One of the secondary or trace elements	See specific nutrient for solution
Dead grayish spots in buds	Bud mold (Botrytis)	Remove entire bud one inch below damage. Drop the humidity
Pungent odors from grow room	Ripening bud smells much more than early bud	Install ozone generator in large rooms. Use "Ona" or "Odor Killer" in small rooms
*Leach or flush growing medium with mild (quarter-strength) nutrient solution. Flush with at least three times the volume of nutrient solution per gallon of medium. **Spray at five-day intervals for 15 days. Use aerosol pyrethrum, and spray under leaves. If problem persists, switch to neem oil and alternate with pyrethrum.		
Drying & Post-Harvest		
Buds smoke harsh	Dried too fast	Move buds into room with 80% humidity
Buds full of mold	Lack of air circulation	Increase air circulation
Spider mites on buds & drying lines	Sloppy growing	Mites escape to ends of lines and subdue them with Tanglefoot™
Buds crackle when smoked	Too much fertilizer at harvest	Too late! Next time flush plants with water ten days before harvest

About Spraying

Use only contact sprays approved for edible fruits and vegetables.

Warning: Do not use TOXIC SYSTEMIC CHEMICALS! Read the entire label on all sprays. The toxic or active life of the spray is listed on the label. Wait twice as long as the label recommends, and thoroughly wash any foliage before ingesting it. Toxic life is many times longer indoors, because sunlight and other natural forces are not able to break down chemicals.

Sprays are beneficial if not overdone. Every time a plant is sprayed, the stomata are clogged and growth slows. At 24-28 hours after spraying, rinse leaves on both sides with plain water until it drips from leaves. Avoid sprays that leave a residual during the weeks before harvest. Spraying increases chances of gray (bud) mold once dense buds form.

Phytotoxicity is the injury to plants caused by sprays. Symptoms include burned leaves, slow growth, or sudden wilt. Spray a test plant and wait a few days to see if spray is phytotoxic. Water plants before spraying. Phytotoxicity is diminished when more liquid is in foliage.

Temperatures above 68°F (20°C) make virtually all sprays, even organic ones, phytotoxic and damaging to foliage.

Intense light causes leaves to take in the chemicals too quickly and will often cause leaf damage.

Spray early in the day so ingredients are absorbed and foliage dries. Spraying two hours or less before lights-out can cause foliar fungus when water sits on leaves too long.

Do not mix two products. It could change the characteristics of both.

Warm temperatures mean spraying twice as often, because the bugs breed twice as fast.

Use a clean, accurate measuring cup or spoon. Measure quantities carefully!



A pump-up sprayer with a spray wand allows you to deliver spray under leaves where most pests live.



Curled leaves are the result of mixing and applying sprays that are too strong. The natural spray applied to this plant was mixed double-strength.



Powder fungicides are easiest to apply with an applicator that disperses the powder evenly on foliage.



This grower is taking no chances. He suited up to avoid any contact with sprays.



Hold foliage back so you can spray under the leaves where most pests reside.



Too strong a spray caused brown burn spots and made this leaf curl downward.

Mix pesticides and fungicides just before using them, and safely dispose of unused spray. Mix fertilizer and use for several weeks.

Mix wettable powders and soluble crystals in a little hot water to make sure they dissolve before adding the balance of the tepid water.

Use chemical sprays with extreme care, if at all, in enclosed areas; they are more concentrated indoors than outdoors in the open air.

Use a facemask when spraying, especially if using an aerosol fogger.

Spray entire plants, both sides of the leaves, stems, soil, and pot. Be careful with new, tender-growing shoots; they are easily burned by harsh sprays.

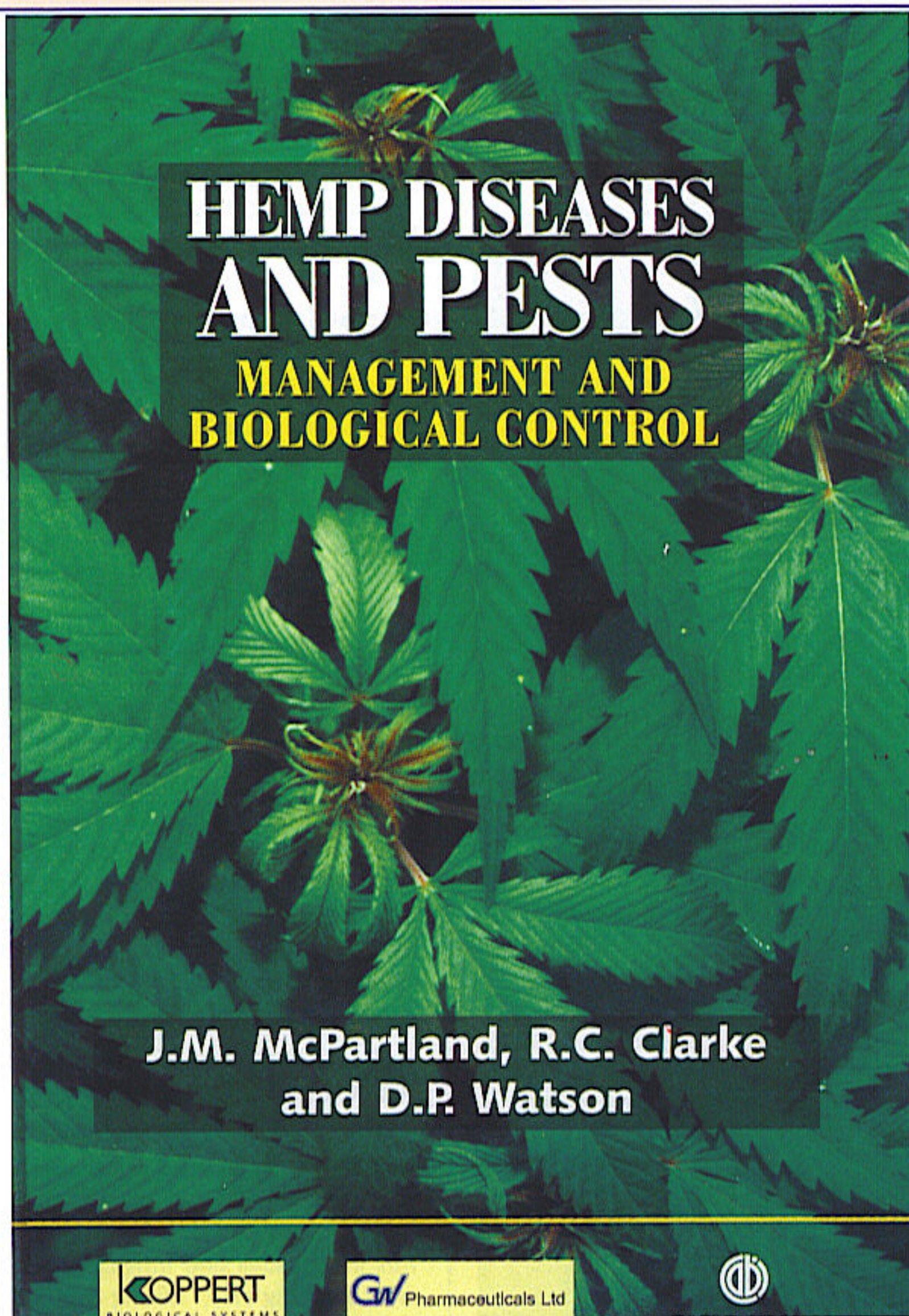
A one quart (0.9-1.8 L) or two quart pump-up spray bottle with a removable nozzle that is easy to clean is ideal. Keep a paper clip handy to ream out clogged debris in nozzle.

A 1-2 gallon (3.8-7.6 L) sprayer costs less than \$50 and works well for large gardens. An application wand and nozzle attached to a flexible hose makes spraying under leaves where insects live easy. Plastic is recommended; it does not corrode or rust.

Electric foggers work well for large jobs. The spray is metered out a nozzle under high pressure, which creates a fine penetrating fog.

Wash the sprayer and the nozzle thoroughly after each use. Using the same bottle for fertilizers and insecticides is okay. Do not mix insecticides and fungicides together or with anything else. Mixing chemicals could cause a reaction that lessens their effectiveness.

Raise HID lamp out of the way so mist from spray will not touch the bulb; temperature stress, resulting from the relatively cold water hitting the hot bulb, may cause it to shatter. This could not only scare the hell out of you, it could burn eyes and skin. If the bulb breaks, turn off the system immediately and unplug!



Hemp Diseases and Pests is a detailed trouble-shooting guide focusing on diseases and pests of cannabis that arise in greenhouse, growroom, and outdoor crops. Pests and diseases can be identified by written descriptions, plant symptom keys, detailed line drawings, and photographs. Organic methods are emphasized, with explicit instructions for biodynamic techniques and biological pest control.

Stats: oversized hardcover (British A4-paper), 251 pp.

Profusely illustrated: 111 black & white photos and drawings, 86 color photos, 36 tables and charts.

More info and ordering: Jorge's site: www.marijuanagrowing.com

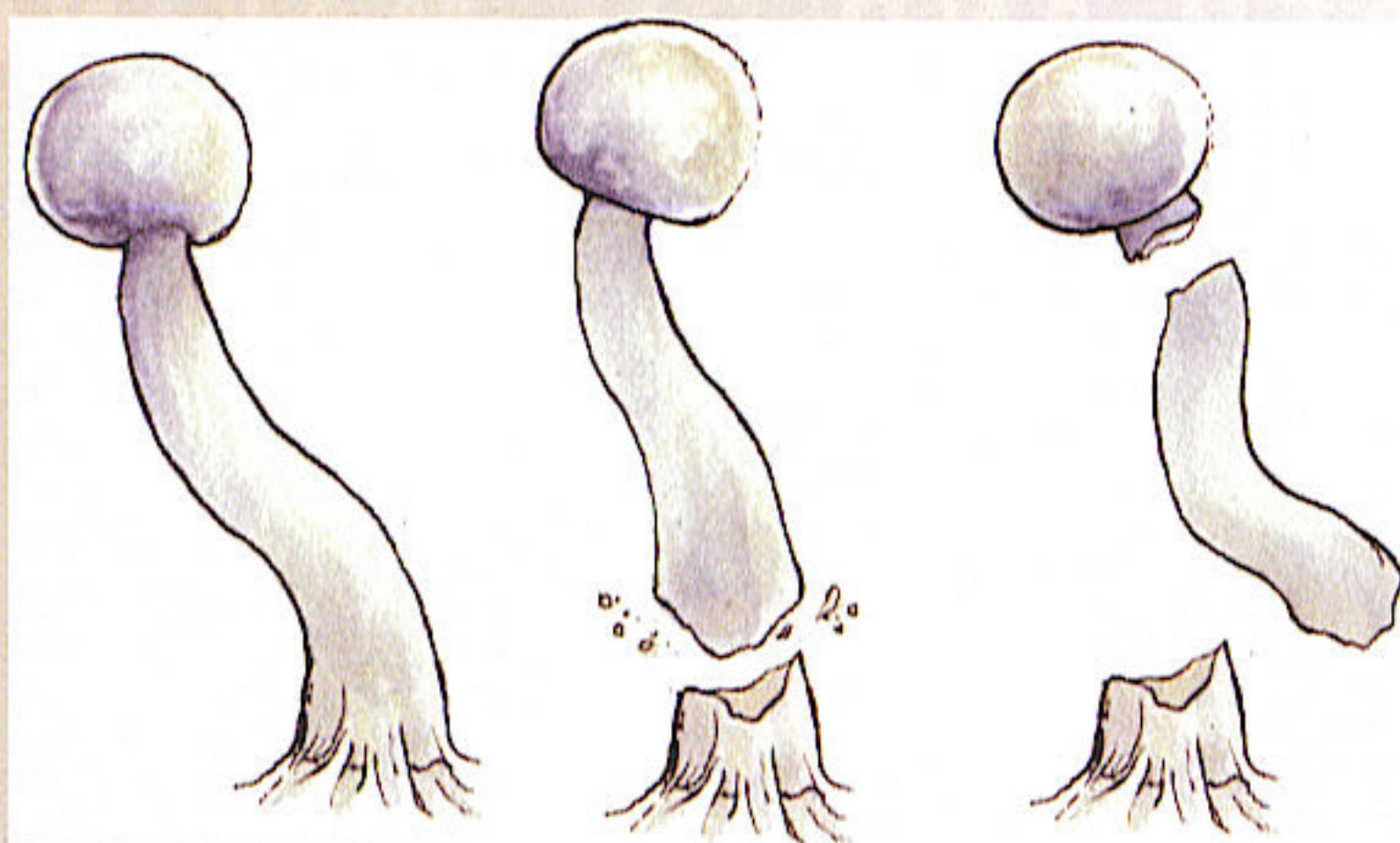
Oxford University Press: www.oup-usa.com; in Europe: www.cabi-publishing.org/Bookshop

Copies also available at Ebay and Amazon.com

Chapter FIFTEEN HASH AND OIL MAKING



This piece of Swiss hash was collected and pressed shortly after harvest.



Resin glands generally break off near the bottom of the stalk and just under the round head.

fumes. Chemical damage may result from premature use of the end-product before all solvents and residuals have been extracted. You can find much information on these

Introduction

Hashish is the connoisseur's smoke. Hashish, also called hash, is the resin heads of glandular trichomes that are collected, pressed together, and shaped. The more resin on the input material, the better the hash. Here we will touch on the basics of making hashish using safe extraction methods. I have omitted detailed information on chemical extraction methods using butane, acetate, different alcohols, etc., because of possible health risks from explosion, fire, and

subjects at www.overgrow.com.

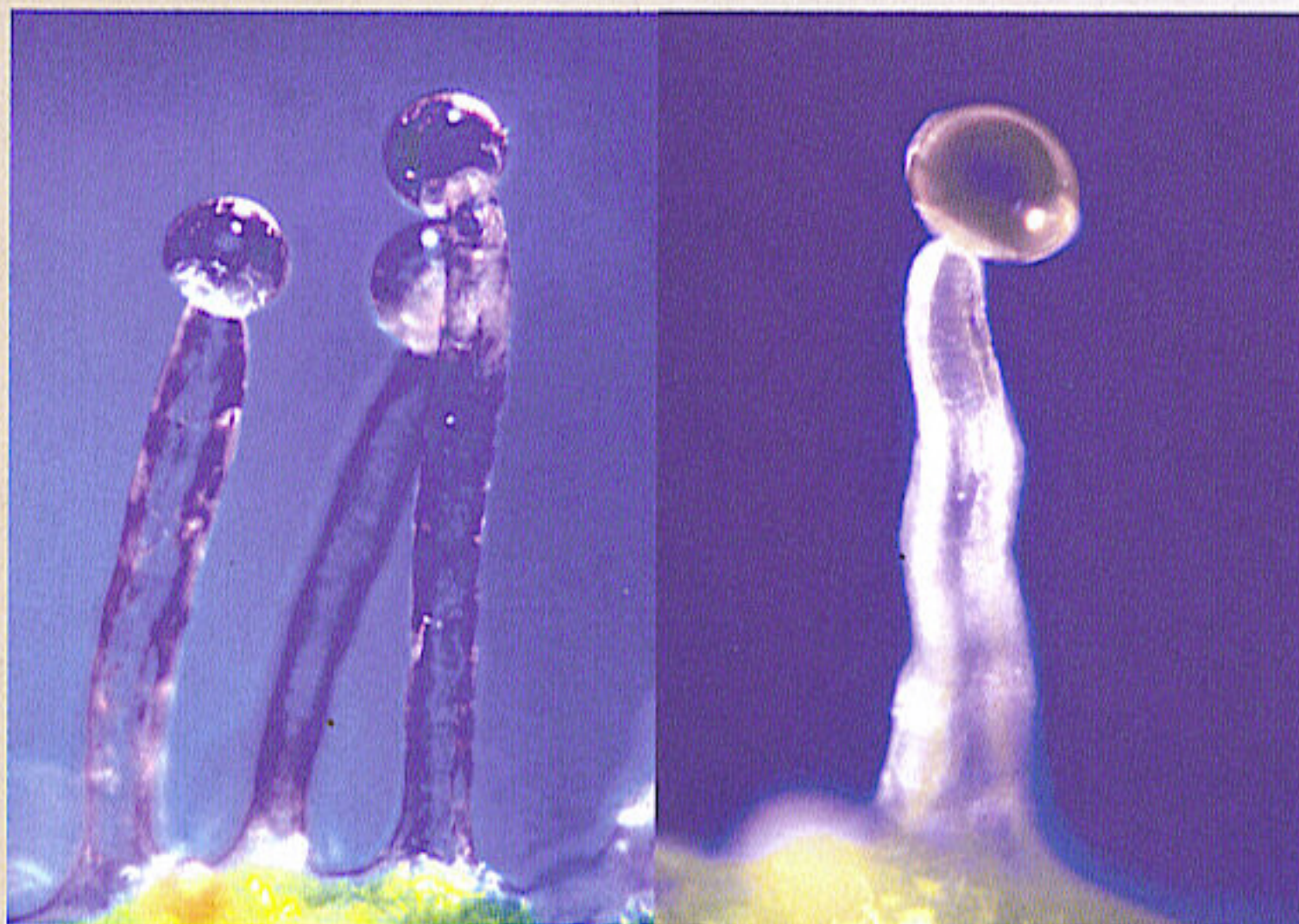
Resin can be collected by scraping it from your hands after handling resinous plants or buds. It can be scraped from tools, too. Resin can be collected by separating it from foliage and letting it fall through a sieve. Or it can be separated from foliage using cold water and sieves.

Before Making Hash

Make sure your plants are as clean as possible. Any oil-based residues on leaves will show up in

the hash. For example, if extracting resin with water, you can see impurity residues as a sheen of oil in the water. During the month before harvest, do not use any harmful chemicals that leave residues. I prefer to use only water-based organic products to avoid potential health risks to the consumer.

Flush plants with water for seven to ten days prior to harvest, to remove built-up



Capture resin glands with small heads with a smaller mesh sieve. Courtesy of the Greenhouse.

Pollen - In Europe and other parts of the world, sieved resin powder is called pollen. The term is used because the two look similar, but resin powder is not pollen. When you hear somebody talking about "pollen," you know they are referring to resin powder.

fertilizers in the soil and foliage. This will help ensure clean, sweet-tasting hash.

Freeze First - Collect more resin by making foliage and resin glands brittle. Cold, brittle resin gland heads snap off and separate easily. Once dry, freeze leaf trim immediately to prepare for making hash. Place leaves in freezer for an hour or longer. Remove them from the freezer, and use a dry or wet sieve to separate gland heads from foliage.

Yield per gram of leaf and small buds

Quantity	Dry Sieve	Water Extraction
100 gm leaf	4-6 gm	6-10 gm

The yield from 7 ounces (200 gm) of leaves and small buds is around 0.2-0.7 ounces (6-20 gm) with the average around 0.36 ounce (10 gm). The quantity of hash produced depends in large part upon the quality of your original material.

Clean stems, dead material, large leaves with no visible resin, and other debris leaf and bud before making hash with it.

Male plants contain resin with THC but much less overall than female plants.

Outdoor plants are subject to wind, rain, dust, etc., which may prevent resin growth or cause much of the resin to be knocked off the plant. Because they live in a protected environment, indoor plants are able to exude as much resin as possible. Such plants with heavy resin make the best hash. Great hash comes from the close



Your tools and hands are a great source of "finger hash." Scrape the resin from tools and manicuring gloves.

Keep the entire operation clean. This is the key to keeping everything separated properly and having minimal contamination.



This piece of "finger hash" was scraped from fingers and trimming tools in a single day of trimming!



This beautiful brick of Moroccan hash was pressed a month before the photo was taken. The resin crystals glisten in the sunlight. Now European and North American aficionados are learning to make better hash!

trim around the buds.

Sativa-dominant strains have smaller trichome heads than *indica*-dominant strains. Smaller mesh sieves do a good job of separating smaller resin heads.

Hand Rub Hash

Hand rubbing hash is simple and easy, but horridly inefficient and wasteful. All you need to hand rub are a good pair of hands, adequate cannabis buds, and desire. Much of the resin falls to the ground or becomes "lost" deep within buds or sticks to other foliage. Overall hand rubbed hash is lower quality and contains more debris than sieved or water-extracted hash.

Hand rubbing is most common in the Himalayan Foothill regions of Nepal, India, and Kashmir where "charas" (the Indian word for [hand rubbed] hash) are fairly common. Most small-scale and commercial growers collect the little bit of hash from their hands and tools during manicuring. This is the closest thing to hand rubbed hash most growers experience.

Plants that are best suited to hand rubbing have sticky resin that adheres to hands much better than it sticks to other foliage. At the same

time, the resin must be relatively easy to roll into little balls to remove from hands.

Collect hand rub from healthy, strong, mature plants with green leaves. However, some large leaves may already have started to turn yellow. Remove brown, crisp, and dead foliage before rubbing. Remember, cannabis plants are generally pretty tough and can take vigorous but not abusive rubbing.

Once collected on hands, resin must not be allowed to collect other debris or foliage. Any foreign matter that sticks to resin-laden hands should be able to be brushed off easily.

Gather resin by rubbing individual flowering branches firmly between hands. Slowly move hands up from the bud, continually rubbing back and forth.

Rub palms and fingers in between resin-covered flower clusters so they come in contact with as much resin as possible. Each branch should be rubbed 20-30 seconds or more. After rubbing a few branches, you settle into the intoxicating, hypnotic rhythm. Aromatic fragrances are released as you rub the buds.

The resin sticks to hands slowly at first, but once they are covered with a light sheen of resin, the accumulation process speeds. Brush off any foliage or debris from hands as soon as it sticks so the resin remains reasonably pure.

To remove the resin from hands, rub your palms together so resin clusters together into sticky little balls. At first the resin will ball up relatively quickly. Lump the balls together to form a single piece. Use this piece to rub on resin that is still on your hand to help remove it. If hands are moist or sweaty, soak up moisture with a paper towel before removing hash.

Once collected, knead it in your hand until it reaches your desired consistency. Hand rubbed hash is best enjoyed within a few weeks of collection. Collecting hand rubbed resin is time consuming. An average collector can rub all day and collect a mere five to ten grams!

Sieves

Introduction

The first time I saw sieved cannabis resin was in 1983 at the Cannabis Castle in Holland. Neville, owner of the Seed Bank, had a large silkscreen stretched across a frame that was set on top of a large desk with a glass top. We would toss a handful or two of buds on the screen and bounce them around a few seconds. After two or three rounds of tossing and bouncing, a thin sheen of resin could be found on the top of the glass below the silkscreen. I had never smoked anything so potent in my life!

Resin heads are different sizes. With the help of sieves, you can use the differences in resin head sizes to separate them from other plant matter. Typically, a minimum of two sieves are used to make hash. The first one filters out the large plant matter and larger debris, letting the resin glands and small debris pass through to the second sieve. The first sieve should have 135-150-micron pores. The second sieve allows small resin glands to pass, while it holds back large, mature resin glands. The pores on the second sieve should be from 50-60 microns. You can find silkscreens at your local hobby and art supply store. Printing supply stores also sell framed screens.

To sieve, plants should be as dry as possible and cold (about 41°F [5°C]) so resin glands break off easily. Be careful not to force the plant material through the sieve. Forcing will break more resin glands and smear their contents on the sieve and other plant material. The contents of these ruptured glands cannot be recovered.

Normally, the largest mature resin glands fall first. They are followed by less mature glands and debris including pistillate hairs and plant debris. If you abuse sieving and force too much through the sieve, the hash will be green and of low quality. At best, sieving removes only half of the THC-rich resin in cannabis.

Atmospheric relative humidity can slow the sieving process to a halt because it causes the pores of the sieve to clog. High humidity also

Resin glands come in three basic sizes:

60-70 microns includes Moroccan cannabis and some other sativas.

80-110 microns is the most common size range for many quality cannabis strains

135-150 micron sieves are necessary to capture the mature resin glands of many well-grown, very resinous strains.

Remember, there are several sizes of resin glands. Use the appropriate screen size to collect the most resin powder for the strains you are processing.

remoistens dry plants, thus making it more difficult for resin to fall free.

A micron is one millionth of a meter (1/1,000,000 m) or one-thousandth of a millimeter (1/1000 mm). This length is also referred to as a micrometer, and the symbol used to denote a micron is "μ".

Microns (μ)	Thousandths of an inch
1. 220μ	8.66
2. 190μ	7.48
3. 160μ	6.30
4. 150μ	5.91
5. 120μ	4.72
6. 104μ	4.09
7. 73μ	2.87
8. 66μ	2.60
9. 45μ	1.77
10. 43μ	1.69
11. 25μ	0.98

Make sure the micron size is labeled on sieves. Color coding helps, but there is nothing as good as the micron size of the screen.

Once prepared, break up buds and foliage over a sieve, and tap the sieve lightly to jostle resin heads through the pores. You can also rub the leaves lightly on the sieve, but this will force through more green foliage. Resin powder will



The Resin Heaven from Portland, Oregon, USA, was the first rolling tray equipped with a screen to collect resin.



Sieving low-quality leaves is just about as much trouble as it is worth. The leaf is unsmokable, but still harbors a little bit of resin.



I sifted the 150 μ screen for about a minute and collected enough hash for a flying hit!



This tool box was loaded by an ambitious Swiss grower. He made hash from each crop he grew during the last two years.

sift through the screen. The more resin on the plant material, the more resin that will fall through the sieve. Use a credit card to move the cannabis back and forth across the sieve. Exert minimal pressure on the cannabis to coax the highest quality resin through the sieve. The first layer of powder will be the purest. Sieved hash contains more debris than most other methods, but sieving is a simple and inexpensive method to make hash.

Collect the powder below the sieve. Now the resin powder is ready to press into a piece of hash. Pressing generates a little heat which also helps congeal the resin glands and debris together.

The Pollinator

Mila is a good friend, and she has carried the hash torch for countless connoisseurs. She has spent much of her life learning and teaching how to extract more resin from cannabis. She invented and popularized the Pollinator, a motorized cylindrical-shaped sieve to separate resin powder from leaf and buds. Mila has many ongoing experiments with hash and cannabis, one of which includes teaching the doctors in



This container holds all the different hashes Mila made in Kazakhstan, Central Europe. Every time she found some likely wild cannabis, she would sieve it to extract the hash. Mila used a Global Positioning System (GPS) to pinpoint plant locations for future trips.

Kazakhstan to grow medicinal cannabis.

The Pollinator consists of a drum that turns inside a box. Cold, dried cannabis is placed inside the drum that is made from 150-micron screen. A motor turns the drum, and resin glands fall through the 150-micron screen as the cannabis tumbles inside. Resin is collected below the drum.

Highest quality resin falls through the screen first. Progressively lower quality resin falls through the mesh the longer the drum turns. More green matter and other adulterants fall through the screen when the Pollinator turns for longer periods of time.

First you must prepare the dry cannabis. Put it in an airtight bag, and place the bag in the freezer for two hours. This will make the cannabis hard and brittle, which makes the sieving process much more efficient and productive.

Let the drum turn for two to five minutes. Use a short-range kitchen timer to make sure not to let the drum run too long. As the drum turns, the purest resin falls through the screen first. The THC-rich resin falls onto the bottom of the box underneath the drum.



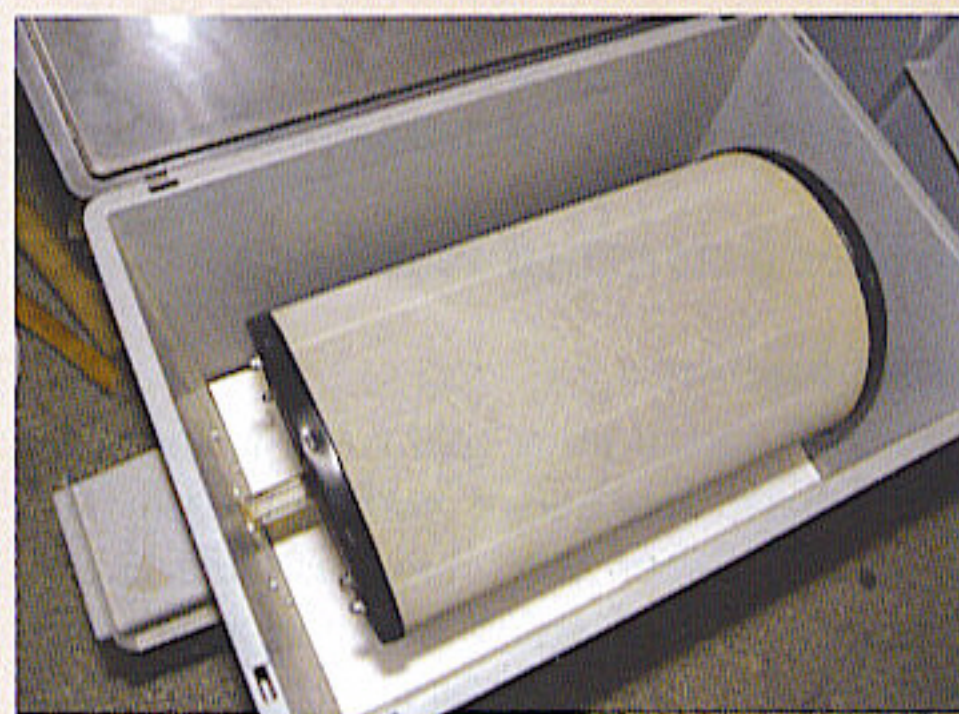
Open the lid of the Pollinator, and lift out the silkscreen drum. Pick up the drum and remove it from the containing box.



Remove the magnetic lid from the drum, and add small leaves and buds. Do not put any sharp sticks or objects into the drum, because they could damage it.



Fill the drum about half full of dry leaf material so the cannabis will have enough room to tumble inside. This action is important to facilitate resin gland separation from foliage.



Put the lid back on the drum, and set it back in the Pollinator. Close the top of the Pollinator, and turn it on for the first turning period.



Remove the drum, and scrape the resin from the bottom of the box. Collect the dry resin, and press it into hash.



An inexpensive microscope enables a magnified view of the resin. To grade the resin, make several batches. The first batch should turn for two to five minutes, second batch five to six minutes, and the third more than six minutes. Inspect each batch of resin with the microscope. You will see progressively more debris in the batches that turned longer.

Water Extracted Hash

Introduction

Hash extracted using cold water is known as water hash, Ice-O-Lator hash, ice hash, THC crystal, etc. When very pure, hash will bubble releasing volatile resins when exposed to a flame, hence the name Bubble Hash. This boiling effect is called "full-melt bubble" hash.

Modern water hash extraction started with "Sadu Sam's Secret" that was published in

HASHISH! by Robert Connell Clarke. Sadu Sam's Secret is simple physics: resin is oil-based and cannabis foliage is water-based. This difference makes separating the two in aqueous solution easy. Heavy, oil-soluble resin glands will not dissolve in water; they are heavier than water so they will sink. Water-soluble material dissolves in liquid, and foliage is lighter than water, which makes it float!

A passage from *HASHISH!* states:

"Sadu Sam's Secret involves stirring a few grams of pulverized flowers or freshly sieved resin powder into a tall container of cool water containing ten to twenty times the volume of water to dry powder. Cool or cold water is essential because warm water softens the resin, which tends to stick together forming an unmanageable lump... The mixture must be stirred vigorously for several minutes until the lumps of the powder disperse. Once stirring ceases, the differing particles in the suspension begin to separate. Plant particles and other light debris (such as plant "hairs") float to the surface. Small, immature resin glands also tend to float. Mature resin glands and any dense debris such as sand and mineral dust sink, settling to the bottom."

Sadu Sam and Mila (the Pollinator) are old friends, and both live in Amsterdam, Holland. Mila continued to play with the separation method and refined it. Within a short time, she combined the dry sieving process with ice-cold water—the outcome was Ice-O-Lator bags. They are three waterproof nylon bags with progressively smaller micron silk screens sewn into the bottom of each. Clean cannabis is chopped and placed in ice-cold water in the bags. The water is mixed. When the slurry settles, the resin glands pass through the screens, and the foliage and debris are retained in bags. The water is drained, and a few nice clumps of high-quality hash remain.

Bubble Man refined the process by adding more bags with progressively smaller mesh. He has been adding screens, and at the time of publication, he uses seven different screens. He found that each screen separates unique sedi-

ments, some of which contain exceptionally pure THC. This hash is so pure that it bubbles when heated. Bubble Man popularized this saying, "If it don't bubble, it ain't worth the trouble." He is a legend on www.overgrow.com.

Water-soluble terpenoids found in cannabis resin contribute to fragrance and taste. The majority of these soluble terpenoids dissolve and are washed out when extracting resin with water. The result is often hash with little flavor and aroma.

Now the hash is out of the bag! Many manufacturers have jumped on the bandwagon. Your time and budget will dictate how many bags you want to use for making water hash.

Use three bags and process the mix twice to extract virtually all of the THC-rich resin. Keep the wet plant material from the first water hash extraction. Freeze it and process again to make more resin. Or you can use five or more bags in a single run and harvest different qualities, some of which are very pure.

Ice-cold water makes trichomes brittle, and agitation knocks the heads off. Strain the mix through filters for increased purity.

Use leaves that have visible resin. Using large fan leaves or immature leaves will result in disappointing hash.

Use a mixer with paddles. If you can, find one with long shanks on the paddles for easy, deep mixing in a five-gallon (20 L) bucket. You can cover the bucket when mixing to help contain splashes. However, moving the mixer around



DO NOT use the mixer with a small cutting blade to mix the bucket full of leaf, ice and cold water. This mixer will cut foliage and bruise resin glands.



Water Extracted Resin

Resin glands are oil soluble and heavier than water.

Bathed in cold water, resin glands separate from foliage easily.

Agitate the mix, and let resin glands settle through a sieve.

Resin glands, as well as other small heavy particles, will fall through the sieve.

Make some practice runs using large leaf trimmings before you delve into your best trimmings!

the perimeter of the slurry helps mix up any dry or stagnant places.

Ice-O-Lator Instructions

The Ice-o-Lator was popularized by Mila, owner of the Pollinator, in Amsterdam, Holland. This water extraction process is a simple, efficient method of extracting THC-packed resin crystals from cannabis plants. Using the Ice-O-Lator is very easy. Here is a brief recap of the process. The instructions below are adapted from Mila's site, www.pollinator.nl where there is much more information on making hash.

You will need:

- Ice-O-Lator set
- 20-25-liter (5-gallon) bucket with lid
- Kitchen mixer - Use the kind with paddles for mixing. Do not use the kind with a short chopping blade.
- Paper towels
- Dinner plate
- Plastic card
- Large mixing spoon
- ± 4.5-11 pounds (2-5 kg) of ice cubes, enough to keep the temperature down to 41°F (5°C)

Keep the temperature of the water just above freezing at 41°F (5°C)

Put in the most resinous leaf trim available. Make sure the chopped cannabis does not contain stems or other sharp plant parts that would damage the precision screen. Prepare buds by pulling apart or cutting into bits before introducing to the mix.

Fill the bucket with ice-cold water to six inches (15 cm) below the rim. Put the bags into the bucket in the proper order. Make sure there are no air bubbles trapped between the bags or the bucket. The bags will hang straight down, nested inside one another and the bucket. Pull the top edge of each bag over the rim of the bucket, hold it down and lock it in place with the drawstring and sliding lock.

Now you are ready to throw in the frozen cannabis.





Put up to seven ounces (200 gm) into the water. Do not put too much plant material into the water because it needs space to mix and for the resin to separate and fall through the sieves below. When there is too much plant material in the water, many resin glands adhere to the foliage.

Add more ice on top of the plant material. This helps ensure the leaves get wet.

Fill the bucket with more water to within two inches (5 cm) of the top of the bucket. Let the mix soak for 15 minutes. Time is needed for the mass of foliage to become as cold as the water. The temperature should be about 41°F (5°C).

Cut two holes in the lid of the bucket—a little bigger than the shafts of the mixer. Attach the paddles of the mixer with the top of the lid in between. Put the lid on the bucket, and turn the mixer on at a low speed. The mixer will stir the concoction. Keep the mixer on and let it mix for 15 minutes.

Remove the lid. Use a spoon to move the plant material on the perimeter to the center. The goal here is to make sure everything mixes evenly. Let the mix soak for five minutes longer. Replace the lid and turn the mixer on again.

Repeat the process until all leaves have been stirred with cold water. Mila likes to mix it for about an hour so all the wet trim and leaves are floating on top of the water.

Turn off the mixer and let the resin settle one more time for about 15 minutes. Remove the first bag that contains all the raw material. Close the top and hang in a place where it can easily drain. Remove the debris in the bag and turn it inside out. Run water through the screen to wash out any latent resin that may have gotten caught in it.

Cleanliness is of paramount importance from beginning to end!

Everything that falls in the second bag will end up in the end product. When cleaning out the first bag, make sure the crystals do not stick on the outside of the second bag. Ample water here is important. Remember, it is a rinsing and separating operation.



Remove the last bag having the finest screen. The water will drip out slower than from any other bag. You may have to hold the bag between your hands and sift the water back and forth across the sieve in the bottom to evacuate all the water because the accumulated hash slurry in the bottom tends to block the sieve. This part is fun! You can watch the slurry of hash congeal as the water drips through the sieve in the bottom of the bag.

Once the water is gone, the ever-changing slurry of hash remains, seemingly floating on the sieve in the bottom of the bag. If the slurry is green and full of contaminating debris, rinse carefully in cold water. The rinse will carry some of the green matter through the sieve.

Concentrate the wet hash in the bottom of the sieve. Fold the sieve and squeeze out more water. Place a couple of paper towels on the



bottom of the screen to absorb more moisture.

Dance around the room with the hash in your hands high above your head. You have made your first Ice-O-Lator hash!

Do not waste the cold water; start another load! You can make up to five batches with the same cold water!

When you are done with the water, pour it on your plants. They love the nutrients!

Remove the semi-dry caked resin from the screen. Scrape it out with a plastic credit card or a small thin teaspoon.

Thoroughly rinse out all the bags to remove resin and debris. Clean screens with 96 percent pure alcohol so no oil-based resin remains. Hang to dry.

Moisture must quickly be removed from the resin powder to prevent mold. Crumble it up and spread it out on a screen or hard surface. I like a screen because you can sop up moisture by pressing a paper towel under the screen.

Another option is to hand press all the water out of the ball. Continue working the wet powder until it transforms into a cohesive ball of oily hash.

Or you can hand press until you have a solid ball. Keep squeezing and pressing, water will become visible on your hands.

Remove the last bit of moisture by flattening out the ball and putting it in the freezer. Freezing expands the volume of water, which will appear on the surface of the hash. Simply wipe off the ice when you remove the hash from the freezer.

When you press powder, the resin crystals will break and the oil will be released. The mix will darken as it oxidizes. The resin crystals from very fresh leaf will remain white, a very high quality.

For more information see: www.pollinator.nl

Water Hash with 15 Bags

The guys at THSeeds in Amsterdam, Holland, are expert hash makers. They taught and inspired my good friend Moño to strive to make the absolute best possible hash. Moño uses



Get all your supplies ready before starting a water extraction run. A bath tub and a clean bathroom make an excellent water hash-making environment.

bags from several manufacturers to separate more and different grades of hash. Moño uses 15 different bags and extracts more resin than anybody else! Moño's work is so impressive that we decided to profile his extraction process here.

More wet sieves separate more and different qualities of cannabis resin. Resin heads are different sizes. They fall through different size pores in a sieve. You can separate different sizes of resin glands with different size wet or dry sieves.

Separate hash with progressively smaller sieves so smaller screens do not clog with wet hash.

Moño has a full array of separating bags from several manufacturers. His laboratory is set up in the bathroom, with the tub the center of attention. He keeps the "laboratory" clean with a shower head attached to a flexible hose. Here is the array of bags he uses to separate the trash from the hash.

The "work bag" is the one that contains the bulk of the processed resin-less leaf. The work bag is usually drained and set aside so the debris inside can be discarded at will.

Moño likes bags with rigid sides. They perform better because they retain their shape inside the bucket and are easier to use when only one person is making water hash.

The process is done in two steps. First, he washes and separates the resin glands from the marijuana foliage using six screens. This process washes out virtually all of the foliage and contaminants.

The hash-laden water that is left over after passing through six bags is separated again by running it through eight more bags. The resulting hash is very clean.

Instructions for a 15-bag kit. The basic process is the same for each bag. You can add more or use fewer bags. Make sure to have everything ready before you start. You will not have time to look for supplies once you start this process.

You will need:

- Bags with silkscreens
- 5-gallon (20-25L) bucket with lid
- Kitchen mixer - Use the kind with paddles for mixing. Do not use the kind with a short chopping blade.
- Paper towels
- Dinner plate
- Plastic card
- Large mixing spoon
- ± 4.5-11 pounds (2-5 kg) of ice cubes, enough to keep the temperature down to 41°F (5°C).

Make sure to have plenty of ice, and do not add too much cold water before adding ample ice. Keep the ice mixed with ice-cold water to make it last longer.

Start First Run

Before you start, remember to clean out each bag and rinse thoroughly with plenty of water. This little bit of timely cleanup will keep gooey resin and debris from clogging sieves and will avoid laborious scrubbing (with alcohol) later. Set bags out to dry. To avoid fungus, make sure the bags are completely dry before storing.

End first run

Start Second Run

Mix and separate again



Use fresh-frozen bud trim. You can use large leaves, but they have little resin.



Fill the bags at least halfway up and above the level of the screens. The screens must be covered with water before introducing plant matter.



Pour in the cold water and ice.



Add the plant matter.



Rub wet, cold leaves between hands to knock off resin glands into water.



The cannabis will float and take a little while to absorb the water.



Mix with mixer for 15-20 minutes. Do not let the mixer's motor or electrical wiring touch water. It could give you the shock of your life!



Add ice and a bit more cold water to bring the temperature to about 41°F (5°C).



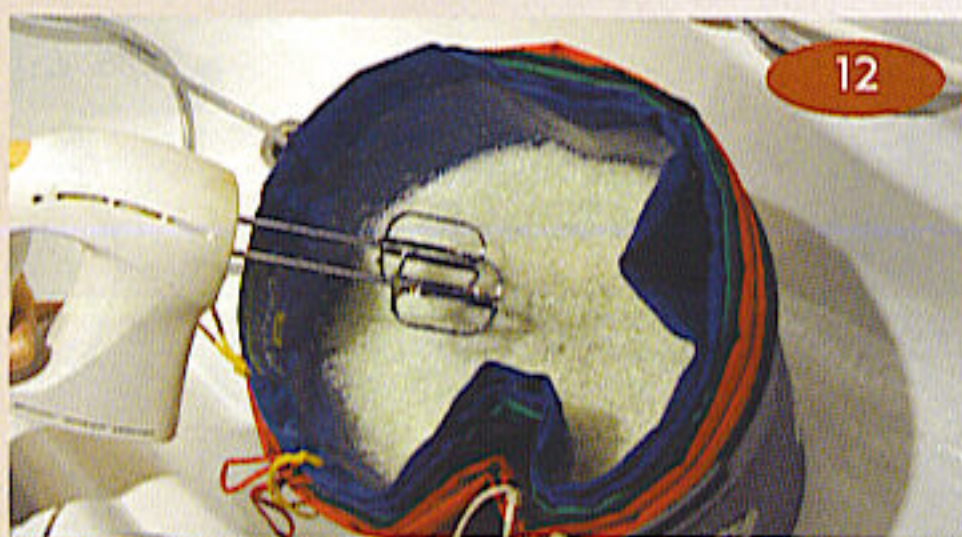
Periodically rinse the paddles with cold water.



Use a large spoon or flat stick to stir and to sink the cannabis until it becomes wet. Continue to stir the mix by hand until completely soaked with water.



Let the mixed-up slurry sit for 15-20 minutes to allow resin to settle through screens.



12

If foam develops, spray and wash away so you can see what you are doing and prevent foam from depositing resin and debris on bags.



13

Spray water on the foam to burst the bubbles.



16

Keep the wet leaf. Put it in a bag and freeze. If the material is good, you can make another extraction!



14

Pull up the top "work bag," taking care to prevent unscreened material from falling into the next bag.



15

Remove the first bag; we call it the "work bag" because it contains the bulk of the leaf material. You can compost the contents or freeze the material to separate again.



Spray and rinse away foam and debris from the wet hash.



Once drained, set sieve on top of absorbent paper towels and rags before removing wet hash with a spoon or plastic card.

Now it is time for the second run. The second run is done just like the first, except there is no foliage to deal with!

Here are the results. We started with 100 grams of pretty good leaf from a 'White Widow' strain. We used water extraction with 15 sieves to separate the resin and plant matter. Below are photos of the wet resin extracted from 150 μ , 120 μ , 104 μ , 73 μ , 66 μ , 45 μ , 43 μ , and 25 μ bags and the dry resin along with the dry weight of each. We found that all hashes were of fair quality but smokable. The bags with a mesh of 45,



You can see the greenish water filled with golden-colored resin glands.

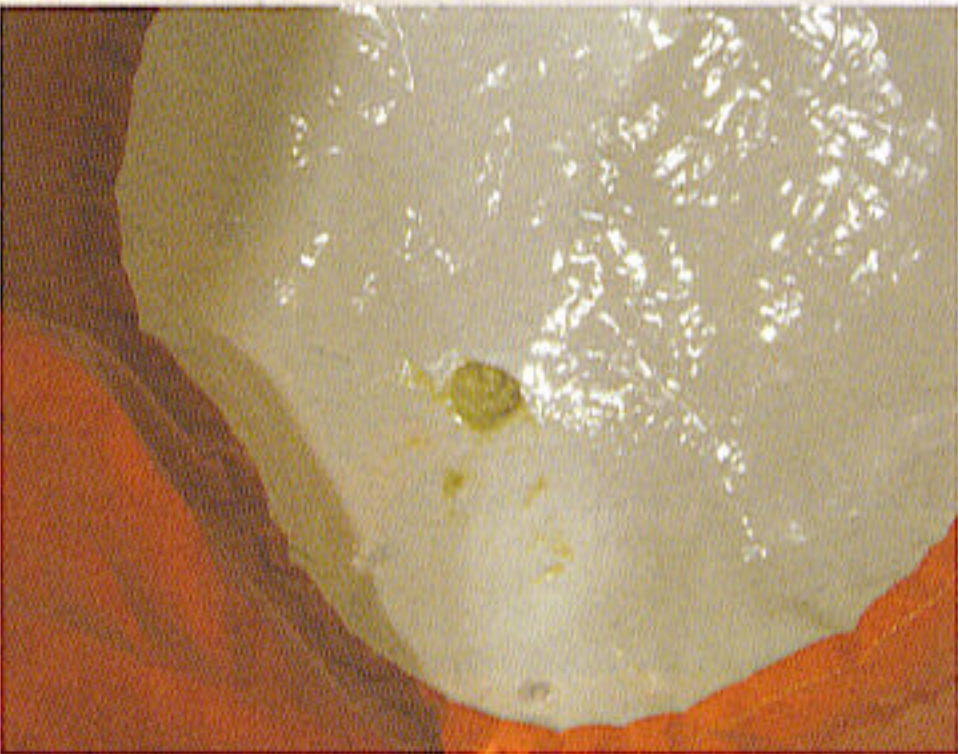


The last of the water in the bucket is loaded with pure resin! The resin in this water will be separated in the second run.

43, and 25 were also good to smoke, but still not the best. The hashes that were separated with the 120µ, 104µ, 73µ, and 66µ sieves were the best, both in quantity and quality.

First Run

1.	220µ	Work Bag
2.	220µ	0.1 gm
3.	190µ	0.1 gm
4.	190µ	0.0 gm



150µ bag = 0.7 gm



150µ bag = 0.7 gm

5.	160µ	0.4 gm
6.	160µ	0.1 gm

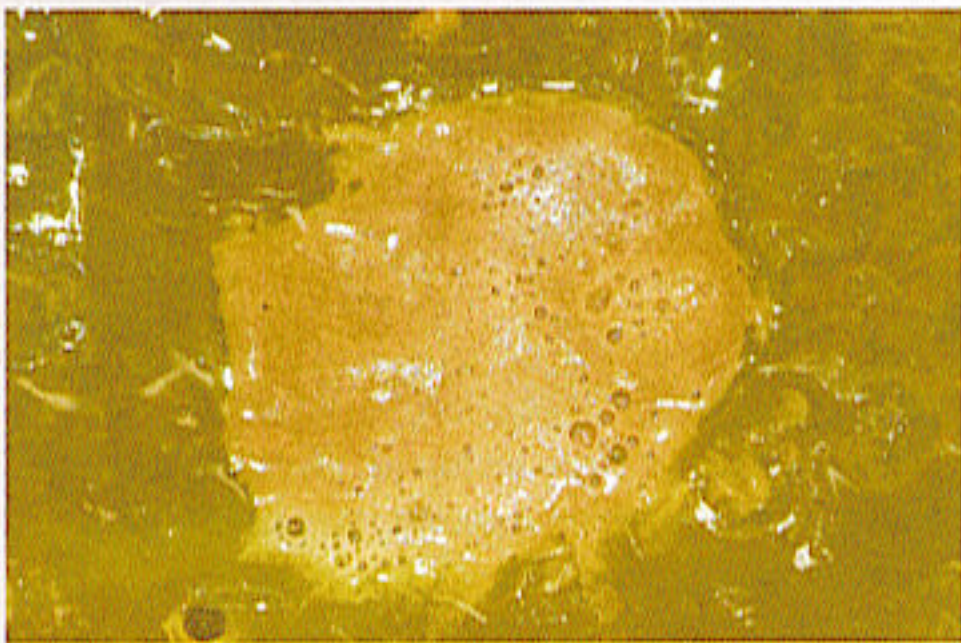
Second Run

7.	160µ	0.4 gm
8.	150µ	0.7 gm
9.	120µ	1.9 gm
10.	104µ	3.1 gm
11.	73µ	1.9 gm
12.	66µ	1.5 gm
13.	45µ	0.3 gm
14.	43µ	0.7 gm
15.	25µ	0.4 gm
Total		11.6 gm

Toss the separated hash on a silkscreen. Lightly press it from the top while holding a paper towel under the silkscreen to absorb the excess moisture.

Look at the water line inside the bucket. You will see a fine sheen of oil or contaminant here or floating on top of the water if foliage contains any residues.

Do not squeeze wet hash in bags. It is too



120µ bag = 1.9 gm



120µ bag = 1.9 gm



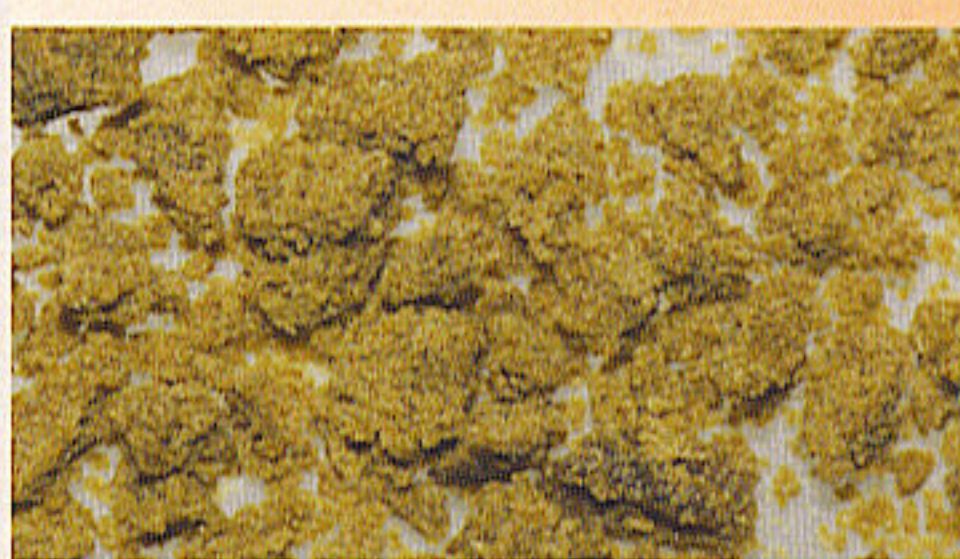
104 μ bag = 3.1 gm



66 μ bag = 1.5 gm



104 μ bag = 3.1 gm



66 μ bag = 1.5 gm



73 μ bag = 1.9 gm



45 μ bag = 0.3 gm



73 μ bag = 1.9 gm



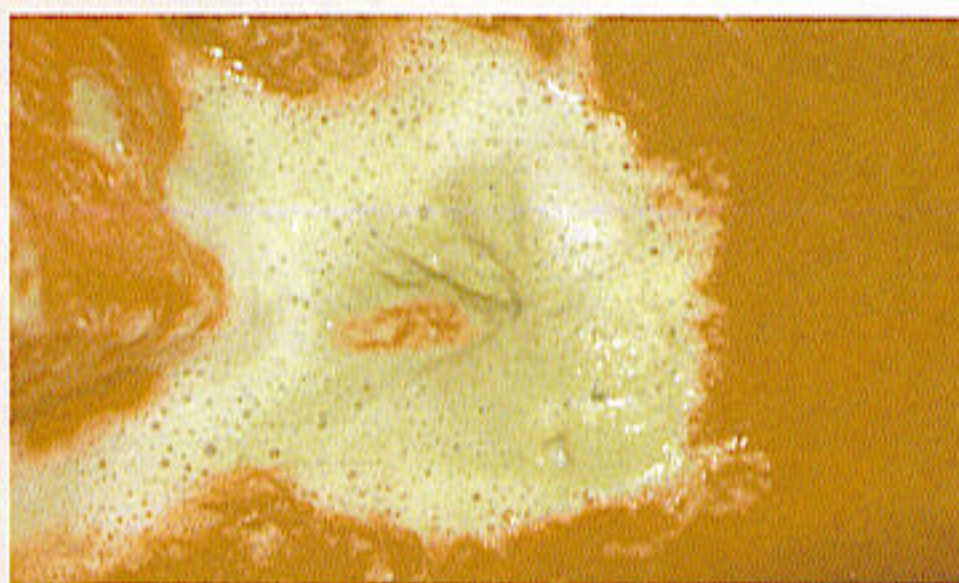
45 μ bag = 0.3 gm



43µ bag = 0.7 gm



43µ bag = 0.7 gm



25µ bag = 0.4 gm



25µ bag = 0.4 gm

4. 120µ bag - good bubble
5. 160µ bag - best for big headed *indica* glands. Debris can also settle here
6. 190µ bag - removes the majority of the big debris out of the settling process
7. 220µ bag - is the first filter where all the big stuff stays

early. Wait until the hash is dry to press, so resin heads will not be bruised or damaged.

This synopsis was adapted from Bubble Man's postings on www.overgrow.com.

1. 25µ bag - most often full of *sativa* full melt and physically the smallest bag
2. 45µ bag - nice head hash - most often consistent and yellowish to white in color
3. 73µ bag - full melt all the way

Washing Machine Hash

On a recent trip to the tropical region of Colombia, I was able to record how expert grower friends made hash in volume. They learned this technology from Mila. This informa-



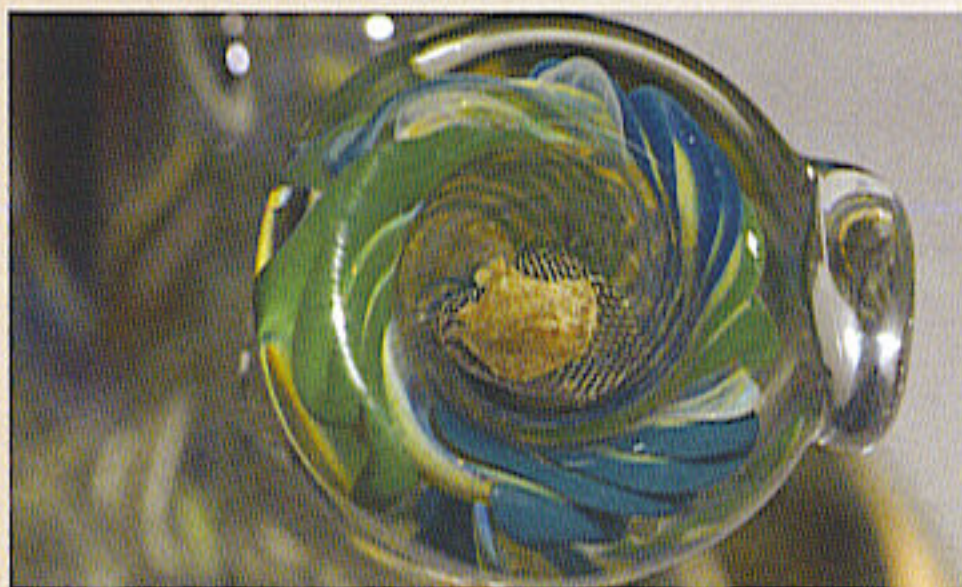
The color of water should be light green, which signifies all the hash and impurities have been cleaned out. Dirty water contains more contaminants.



Here are the different grades of hash from two runs using 14 bags.
The hash labeled with black letters is first run. Red numbers signify second run.



We loaded up the first run into separate vials; each is labeled with the micron (μ) size used to make the water extraction.



Once pressed quickly by hand, the hash is ready to smoke. We tossed it into a bong on top of a stainless steel screen.



Let's see what happens to this wafer of fresh hash when we apply a little flame.



Voilà! It bubbles, which means it is very pure.



The second test of purity is the amount and color of ash after the burn. White and clean—pure!

tion is very useful to process the leaf that is left over after the harvest. Using an everyday washing machine will save hours of labor. Following all the steps and paying attention to the water temperature in this simple process will extract all remaining cannabinoids from the leaves.

The best bet is to purchase the proper bags that have been tested. Mila and other manufacturers make different bags for outdoor and indoor crops. Plants grown outdoors have smaller resin heads than plants grown indoors and require a smaller mesh bag to collect the resin.

A washing machine filled with cold water is used to agitate the leaf and glands that are located inside of a zipped silkscreen Ice-O-Lator bag. This process separates the resin glands from the green leafy material. Once separated,



Use an everyday heavy-duty washing machine.



Fill the "zipped" Ice-O-Lator bag with leaf and place in the washing machine filled with cold water and ice.



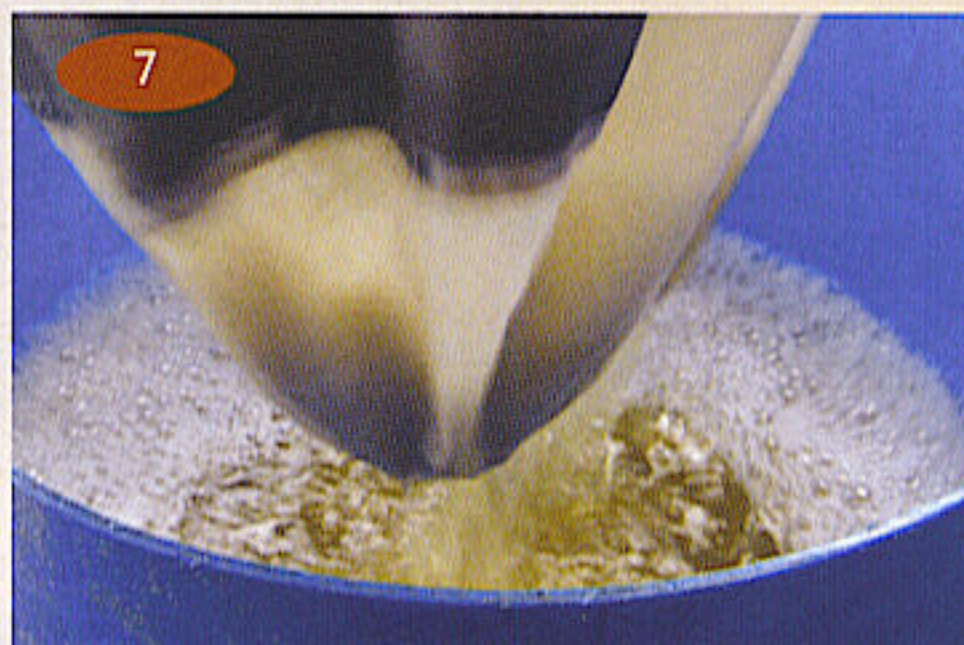
3
Stuffing bags of cold leaves into the washing machine takes a little patience.



6
Drain the hash-laden water and strain through an Ice-O-Lator bag.



4
Make sure to include plenty of ice so the mix stays below 41°F (5°C).



7
Remove large Ice-O-Lator bag from the container.



5
Turn the machine on and let it agitate for 12 minutes to knock loose and separate resin glands from foliage.



8
Squeeze excess water from the large Ice-O-Lator bag.



Dry the wet resin.



The dried resin.



Once dry, Colombian hash makers rolled and pressed the hash into a beautiful ball.

resin glands fall through the sieve into the washing machine water. The leafy material stays inside the bag. The hash-laden water is evacuated out the washing machine's drain hose and separated from the water in a simple filtering process.

The machine is filled with ice and ice-cold water. Cold water is used to keep the resin glands intact and facilitate separation from the leaf. The principle is simple. Resin is oil-based and leaf is water-based.

First, the Colombians place paper bags of 500 grams of leaf in the freezer for one and a half hours. Cold temperatures make the leaves brittle, which allows them to easily separate from the resin glands.

Next, the two, one-pound (450 gm) bags of the cold leaves are loaded into a zipped Ice-O-Lator bag. The drum of the washing machine is filled with very cold water. Chunks of ice the size of your fist are added to the water until the desired temperature of 41°F (5°C) is achieved.

Two zipped Ice-O-Lator bags are loaded into the drum and the machine turned on to agitate for 10-12 minutes. Two bags are used to keep the machine in balance. As the machine agitates the bags, resin glands slip out through the mesh of the bags into the water.

The next step is to evacuate

the resin-laden water out the drain. The drain water is sifted through an Ice-O-Lator bag to remove any remaining leaf. The water is collected in a larger bag placed in a large container. Once all the water is evacuated, they lift the large bag from the container. The "clean" water flowed out the sieve in the bottom of the big bag, and the wet resin stayed in the big bag. They squeeze the last of the water by hand out of the big Ice-O-Lator bag and the resulting unpressed hash is set out to dry. Every one-kilo bag of leaves yields 30-40 grams of dried resin. In a single 14-hour day they can process 100 kilos of leaf and transform it into three kilos of quality resin that is later pressed into hash.

Resin Extraction for Cooking

Cannabis butter and oil are simple to make. Each takes a little time to make, but large batches can be processed and stored in the refrigerator or freezer.

The psychoactive cannabinoids dissolve in butter, cooking oil, or alcohol (see "Tinctures" below). Dissolving the resin in the butter, oil, or alcohol makes it available for absorption by the body. Cannabis butter contains about 80 percent of the cannabinoids that were in the original foliage used to make it.

Heat 1.6 quarts (1.5 L) of water in a large pan on the stove. Add 4 ounces (112 gm) of marijuana leaf, one pound of butter (or margarine) and stir.

Bring the liquid to a boil. Put the lid on the pot and simmer two hours on low heat, stirring occasionally.

Strain the mix through a colander, catching the liquid below. Press the wet foliage to get all the liquid out.

Pour 0.5 quart (0.5 L) of boiling water over the wet leaf to wash out remaining butter. Press the leaves to squeeze out all the liquid possible.

Let the mix stand and cool. Within an hour or two, the mix will separate—water on the bottom and cannabis butter on top. You can speed the process by placing the hot mix into the refrigerator.

Pour off and discard the water, and retain the cannabis butter.

Use the butter in any recipe that calls for butter. Use small portions until you are familiar with dosage and effects. Be careful when consuming; the butter is quite potent!

Cannabis vegetable oil is made very much like cannabis butter.

First, you substitute one quart (1 L) of vegetable oil instead of butter.

Heat 1.6 quarts (1.5 L) of water in a large pan on the stove. Add 4 ounces (112 gm) of marijuana leaf, one quart (1 L) of vegetable oil, and stir.

Bring the liquid to a boil. Put the lid on the pot, and simmer two hours on low heat, stirring occasionally.

Strain the mix through a colander, catching the liquid below. Press the wet foliage to get all the liquid out.

Pour 0.5 quart (0.5 L) of boiling water over the wet leaf to wash out remaining butter. Press the leaves to squeeze out all the liquid possible.

Let the mix stand and cool. Within an hour or two, the mix will separate. Once completely separated, put the mix into the freezer. The water will freeze in 4-6 hours. Pour off the cannabis oil. If you are using olive or peanut oil, they will coagulate in the freezer and cannot be poured off. Use a spatula to scrape the oil from the water.

The oil will liquefy at room temperature. It will keep for about a month at room temperature. Keep in the freezer for longer term storage.

Use cannabis oil in recipes as you would any vegetable oil.

Cannabis Tinctures

Use liquor as a solvent to dissolve resin glands into a potent cannabis potion. You can use any liquor, but the higher the percentage of alcohol, or proof, the quicker and more efficient the process. You can let the spirits evaporate so the tincture contains virtually no alcohol.



Well-made cannabis oil is extremely potent, often registering more than 70 percent THC!

If you prefer a flavored drink with alcohol, use Kahlua, Cointreau, Galliano, etc. Just remember, liqueurs contain a lower percentage of alcohol, and the extraction process will take longer.

Clean 4 ounces (112 gm) of clean cannabis leaf in two quarts (about 2 liters) of lukewarm (90°F [32°C]) water. Stir the leaf and water so they are well-mixed and the leaf is wet. Keeping the leaves whole makes them easier to work with. Strain out the leaves with a colander, letting the greenish water drain into a receptacle. This step will wash out much of the green chlorophyll.

Place the wet foliage in a bowl and cover with one quart (0.95 L) of 80 proof alcohol of your choice. Stir the blend until the alcohol and foliage are well-mixed. Make sure all foliage is covered with alcohol. Put a lid on the bowl so the alcohol cannot evaporate, and let it sit for 48 hours.

Take the lid off the bowl, and let the mix sit uncovered for 12 hours, until about half the alcohol evaporates.

Stir the brew again so it is well-mixed, and pour it through a coffee filter into a receptacle. Use the coffee filter to wring all liquid out of leaves.

Pour the alcohol through the leaves again, and wring out the liquid.

You will have about two cups of cannabis tincture concentrate that is ready to use. Or you can boil the mixture down to concentrate it more. The tincture will have 60 percent or more of the THC contained in the entire four ounces (112 gm) of raw material.

The tincture can be added to recipes in lieu of other liquids such as water, wine, etc.

Store concentrated tinctures in a cool, dark place to avoid early degradation. Heat and light degrade tinctures quickly. Use the tincture in one to three months.

Be very careful when you drink the tincture; it is potent! The buzz is similar to the one you get when eating cannabis, but it comes on in less time.

This is a shorthand version of cannabis extraction using butter, oil, and alcohol. For more complete information see the *Marijuana Herbal Cookbook*, by Tom Flowers, Flowers Publishing, 1995.

Hash or Cannabis Oil

Hash oil is a concentrate of hash or marijuana (cannabis oil) that has been dissolved in nasty hydrocarbon solvents such as ether and alcohol to extract the THC. Hash and cannabis oil frequently retain residues from solvents used to extract the THC. These residues are a health risk. The oils can be very concentrated and potent.

Honey oil was somewhat popular in America in the early 1970s. The oil was a translucent golden-amber color. The oil transformed from stiff, toffee-like consistency to runny oil when warmed. Cannabis oils are normally dark in color because they contain chlorophyll and other contaminants. Filtering the oil through

charcoal will remove virtually all of the impurities.

Hash oil never became super popular because it is inconvenient to smoke and many users do not want to be exposed to the health risks associated with the solvents used for processing. There are many safe ways to separate the THC-potent glands from the foliage.

The oil can be wiped on joint papers, cigarettes, pipe screens, hot knives, etc. A popular smoking method is to smoke it in an oil pipe, a stem with a glass bubble on one end. A little oil is placed inside the glass bubble. When heat is applied, the THC vaporizes and is inhaled through the stem.

Volatile solvent extraction

We do not recommend volatile solvent extraction because it requires the use of dangerous chemical solvents such as isopropyl alcohol, ethyl alcohol, and white gas.

Cannabis is soaked in the solvent, and the solvent is removed by evaporation. The resulting residual is a sludge that contains chlorophyll, plant waxes, other debris, and cannabinoids.

Isomerization is a chemical resin extraction process that was very popular in the 1970s and early 1980s. The process has fallen out of favor because of the harsh and dangerous chemical solvents—white gas, sulfuric acid, hydrochloric acid, etc.—used in the process.

Butane cannabis oil is made by passing butane gas through chopped cannabis. The butane dissolves the THC and transports it out a drain where it is collected. The captured butane contains THC. The butane is evaporated away by setting the collection container in a pan of warm water. Once the butane has dissipated completely, the residual honey-colored oil is scraped from the bottom of the collection pan.

Butane hash oil is dangerous to make because the process involves using a quantity of butane in an open container. The fumes are toxic and a small flame or spark could cause the butane to explode. People who make butane hash should make it in a well-ventilated or outdoor location.

Jelly hash is a combination of high quality hash and cannabis oil made from butane extraction. The typical recipe contains eight parts hash and one part cannabis oil (AKA hash oil) usually extracted with butane. Although very strong, the dark jelly hash has a characteristic sticky, oily consistency which makes it difficult to handle.

You can find out more about these processes in *Marijuana Chemistry: Genetics, Processing & Potency*, by Michael Starks, Ronin Press, and *Cannabis Alchemy: The Art of Modern Hashmaking: Methods for Preparation of Extremely Potent Cannabis Products*, by D. Gold, Ronin Press, and, of course, on www.overgrow.com.

Pressing Hash

Introduction

Once collected, resin powder is often pressed to facilitate handling and storage. Bulky resin powder is awkward to handle. It is easily spilled, blown away, and contaminated by dust and dirt. Resin powder is also more difficult to smoke, especially if no screen is available. Once pressed into a piece of hash, the resin is easy to handle, store, transport, and consume. Proper pressing is essential for storage and to slow decomposition.

Pressing ruptures resin glands and warms the resin, causing many volatile aromatic terpenoids to release their aromas and flavors.

You can press the resin powder by hand or with a mechanical device. You can elect to add heat, a drop or two of water, or alcohol while pressing to make less-pure hash stick together in a block.

Mechanical presses must be precise and align well so pressed hash does not ooze out seams. When pressed, heat and friction cause the outer layer of pressed hash to oxidize and turn darker than the interior. In fact, hash can have a dark exterior and a blonde interior packed with creamy resin glands.

Make sure to pre-press water-extracted hash in a piece of cellophane to contain it and help



Remove a few clumps of water-extracted hash from the glass cone.



Ball up the clumps of resin and work it in the palm of your hand, pressing it together with your thumb.



Continue to knead the resin in your hands until it forms into a solid shape.



Press the resin into a wafer. Check out this compressed resin powder. You can see the resin glisten!

get rid of the water. The cellophane will give the pressed hash a shiny skin.

Pressing Small Amounts of Hash

By hand pressing, you experience the transformation of the resin powder into your very own piece of fragrant, dense hash.

To hand press, collect one to four grams of resin powder in the palm of your hand and apply pressure to the powder, working it between the palms of your hands. Also push your thumb into your palm full of resin powder to work it into a piece of hash. Continue this process for 10-30 minutes until the piece of hash is completely pliable and whole. Heat will be generated and help rupture and meld the resin glands together. Relatively pure resin powder will congeal faster than less-potent powders that contain impurities. But a little vegetable matter and debris gives hash different flavors and more body.

Potent resin powder is a creamy white to gold in color. Pressing the powder together and working it in your hands ruptures and oxidizes resin glands, which makes the mass turn ever darker.

Bottle Pressing

Press small amounts of resin powder between cellophane to form a pancake. Fill a long cylindrical bottle with warm water and use it as a "rolling pin" to press the pancake of hash.



Now pressed into a wafer, the piece of hash will be easy to smoke and will burn evenly.

Shoe Hash

Press small amounts of hash by putting resin powder in cellophane and putting it under your heel inside your shoe. Walk around for an hour or so, doing what you would normally. Take your shoe off and voilà, fresh hash!

You can use a laminator—the kind that laminates photos and documents between two sheets of plastic—to press your hash! Simply sprinkle out the best resin powder you can make onto a piece of cellophane. Lay another piece of cellophane on top. Roll it with a bottle full of hot water to get it into preliminary shape and make it easy to work with. Remove the piece of hash from the cellophane; treat it like you would a document and laminate it. If your laminator can control the level of heat, wonderful! You are now ready to pack hash for a rainy day!

Mechanical Pressing

Place resin powder in a plastic bag or cellophane wrapper to contain it while pressing. All the powder will be pressed within the wrapper into a brick or plaque of hash. Poke a few small holes in the bag before pressing to allow trapped air to escape. The bag is placed into a heavy-duty steel mold, and pressure is applied with a hydraulic jack. Hydraulic jacks have a capacity from 10-20 tons and are mounted to heavy-duty steel frames that normally contain a 100-gram mold.

The pressure exerted to form a cohesive block is contingent upon the volume of contaminants in the powder. The more pure the resin powder, the less pressure it takes to form it into a block.

If your hash was made with water, make sure it is totally dry before pressing to avoid mold.

Water hash does not react like dry-sieved hash when pressed. Resin has been melded together in a different way than dry powder.

Pressing the resin when it is wet will trap moisture inside the hash. The hash will not dry completely, and it will not properly gel together later. It will retain a powdery consistency.



Three grams of dry-sieved resin powder that is ready to press.



Cover resin with cellophane and fill a wine bottle with hot water.



Roll the wine bottle over the dry resin powder that is wrapped in cellophane.



This small wafer of pressed "pollen" can be broken off and vaporized or smoked in a pipe.

Dry-sieved resin powder will press easily and stay together under lower pressure when it is relatively pure. If it is adulterated with impurities, more pressure and heat will be necessary

to press it into a block.

Add a little heat to hard-to-press hash that contains impurities. The heat will help the mass congeal so bricks do not need excessive pressure to stay together. But do not heat the resin too much or it will be damaged. Do not forget that pressing also increases heat.

You can also add a drop of alcohol in the form of brandy, whisky, bourbon, rum, etc. Higher alcohol content spirits are favored. The alcohol melds the glands together. Add only a drop at a time; alcohol takes a few minutes to completely penetrate and act. Be careful, add only a little!

Hammering

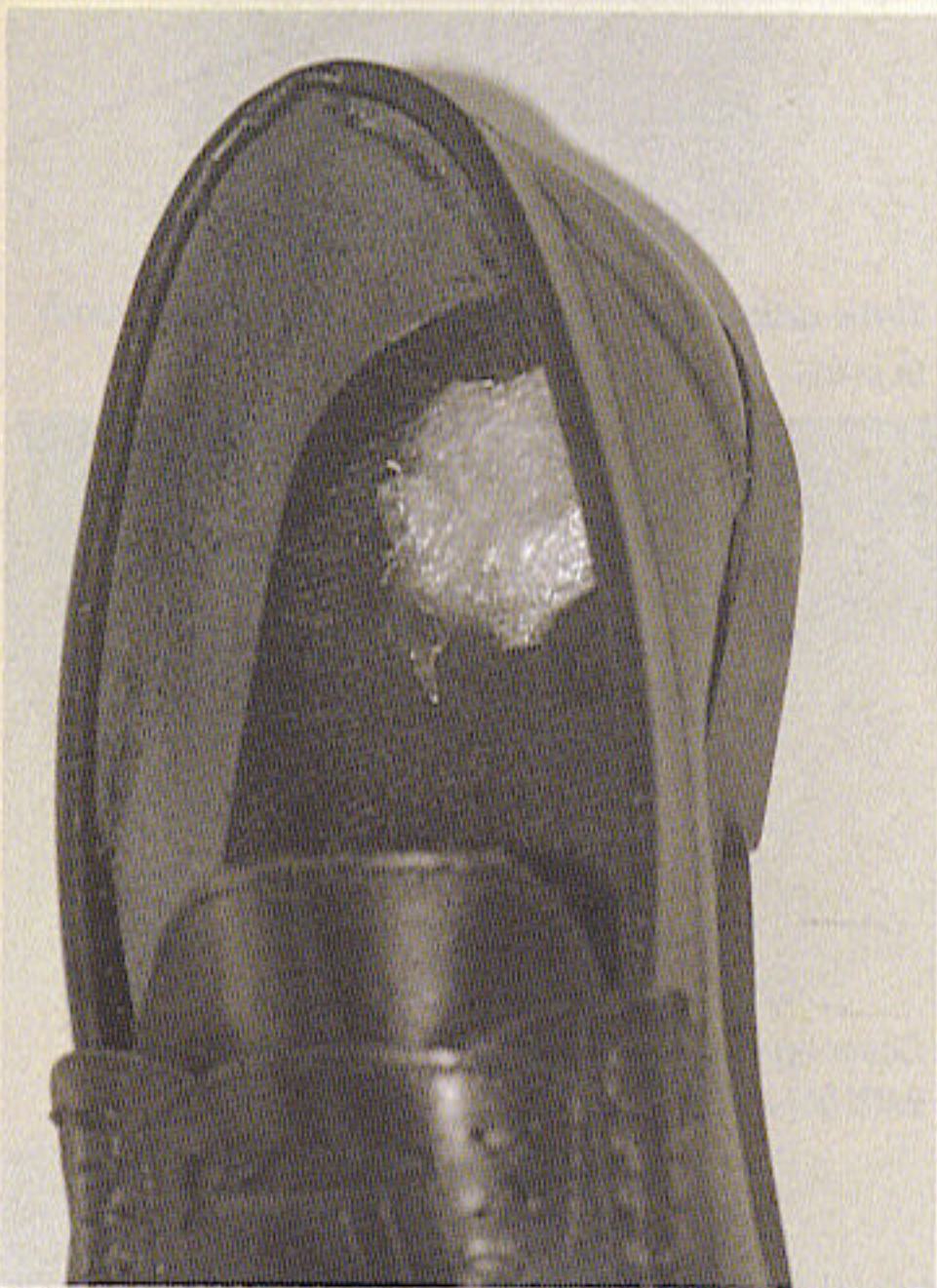
Hammering hash is a popular method of pressing in Morocco but uncommon in Australia, New Zealand, Europe, and North America. Hammering bursts and blends resin glands together into a cohesive mass. Often resin glands are hammered before being hydraulically pressed into plaques.

To hammer hash, place resin powder into an extra heavy-duty plastic bag. Place the bag on a wooden bench, tree stump, board, etc. Place a piece of plywood over the bag. Whack the plywood with a hammer until the resin powder forms a cohesive pancake. Remove the hash

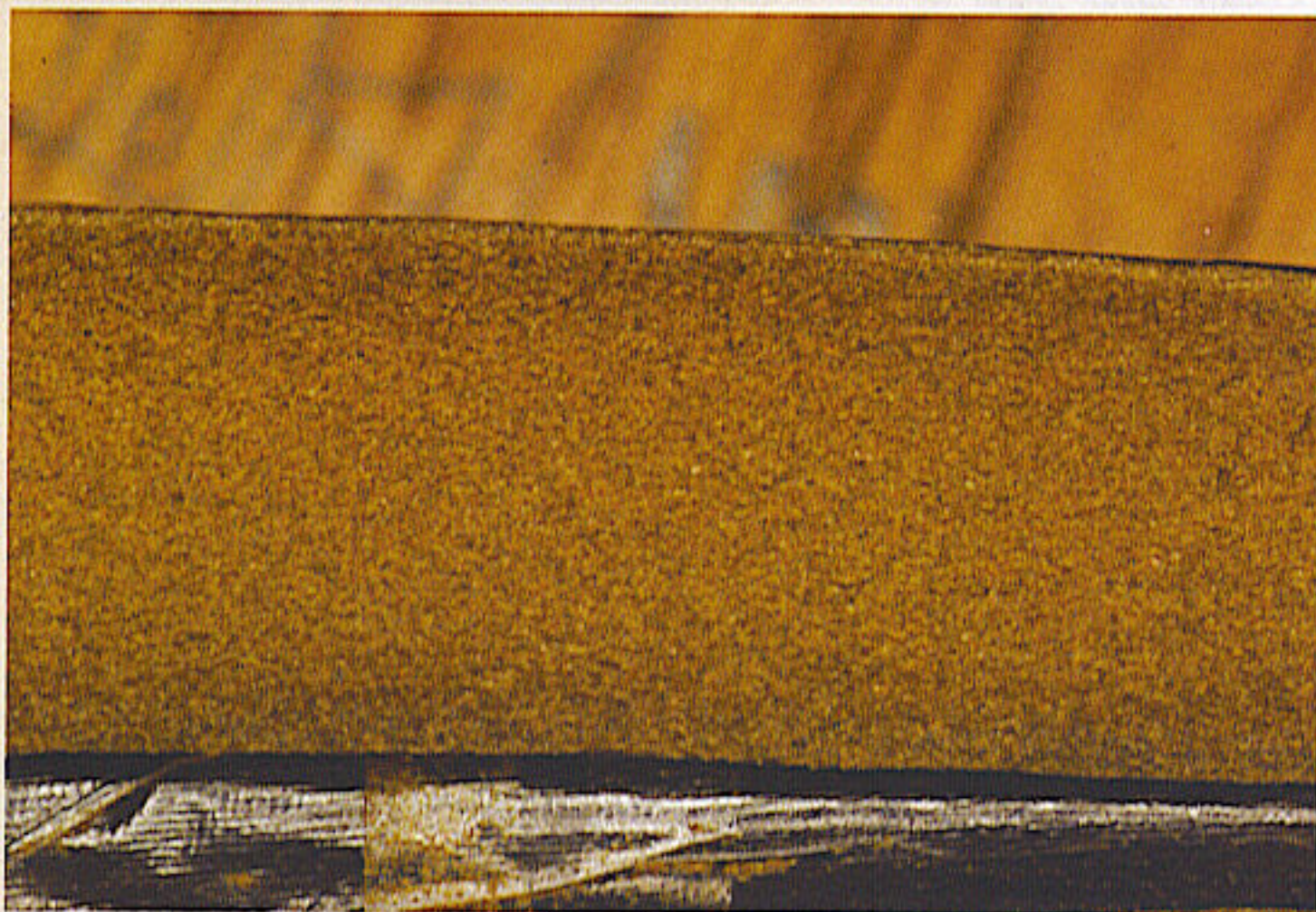
from the bag and fold once or twice to make it smaller and thicker. Repeat the hammering and folding process until the resin glands transform into a sticky piece of hash. Apply a little heat if the hash is slow to form.

Storing Hash

Make sure hash is dry before storing. Moist hash contracts fungus easily and decomposes quickly. Decomposition decreases THC levels. If



Wrap a gram or two of resin in a bit of cellophane. Place it in the heel of your shoe to press into "shoe hash."



This 100-gram brick of pressed hash shows oxidation on and near the surface.

you make hash using ice and water, make sure to dry it well. Dry by pressing the water hash into a flat pancake that has much surface area. Leave the pancake out in an arid room for a few days to dry completely. Cover the hash with a paper towel so dust does not contaminate it. If you made hash with a dry method such as sieving, you should not have to take any extra precautions before storing, unless working in a humid climate.

My favorite way to store high quality water hash is to put it in a glass tube. This way all the resin stays intact until it is consumed. Upon smoking, you should press it a little so it will burn evenly.

Store hash in a cool, dark, dry place. Keep in an airtight container with a packet of silicone crystals. You can also put the hash in the freezer for long-term storage.

For a complete account of the history and detailed methods of production see *HASHISH!* by Robert Connell Clarke, Redeye Press, 1998, www.fsbookco.com. If you want to make the best hash and have a springboard to launch into advanced processes, this is the book!

For current methods of hash making as well as stimulating discussion and interaction, check out the Hashish and Oil Forums on www.overgrow.com.



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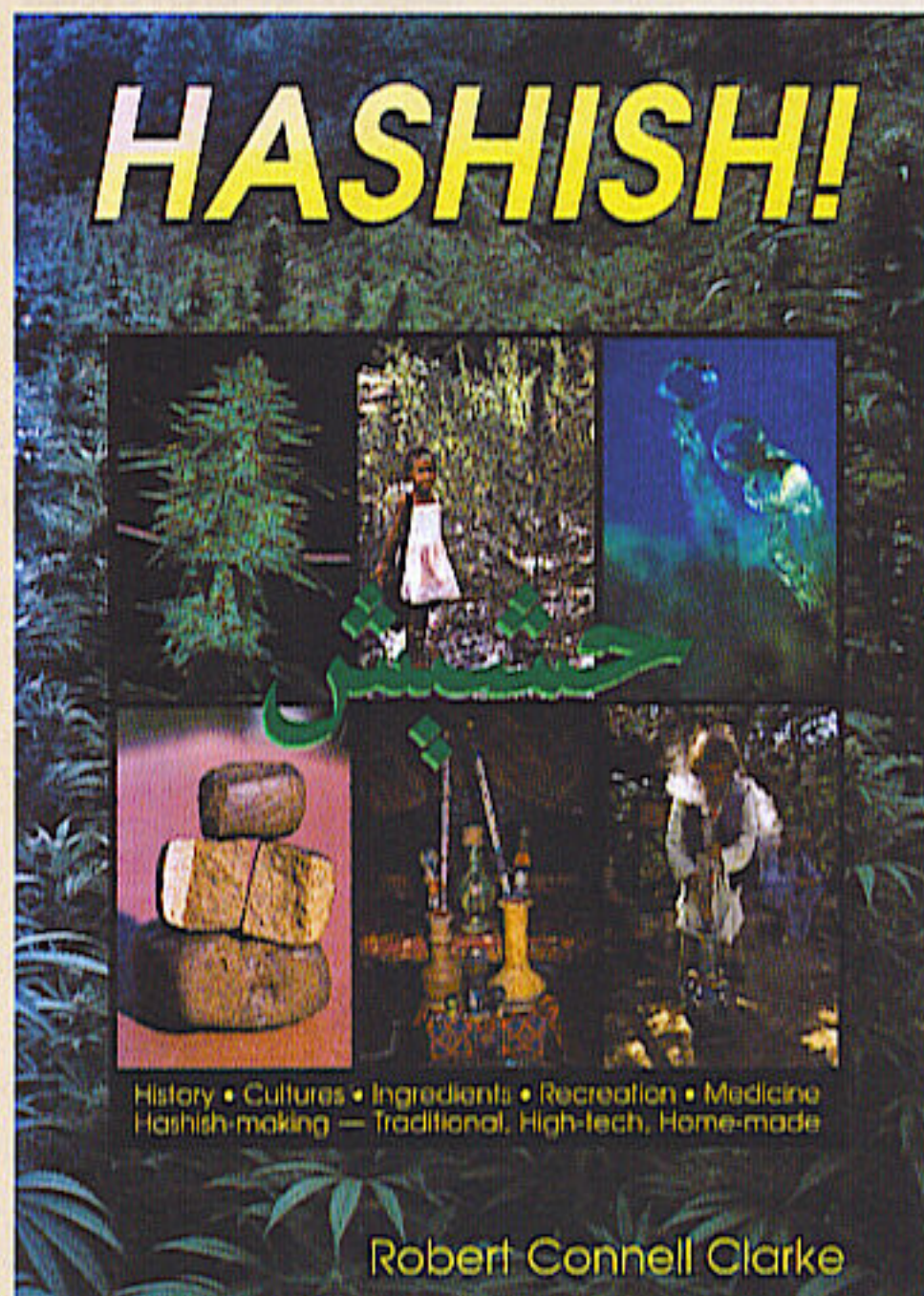
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Beautiful blond Moroccan hash is a mass of creamy, golden resin glands.



The dark gloss on this piece of Moroccan hash is the result of oxidation and being placed in cellophane.



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